THURSDAY, JUNE 3, 1915.

GERMANY AND THE MUNITIONS OF WAR.

In previous articles we have commented upon the stringency which will undoubtedly be felt in time by our enemies in regard to the provision of certain raw materials which are absolutely essential to the manufacture of munitions of war. All accounts which are allowed to leak through from Germany and Austria clearly indicate that this stringency is now becoming acute, and with the advent of Italy as another of our Allies, it will rapidly become almost insurmountable.

From an article which appears in the last issue of the *Engineering and Mining Journal* of New York, based upon a communication made by the director of a great German metallurgical company to an American correspondent, we gather that the shortage is frankly admitted, and some account is given of the desperate efforts which are being made by our enemies to meet it. Germany has evidently summoned to her assistance all the metallurgical skill and chemical knowledge at her disposal in attempts to improvise substitutes for the materials of which she has been deprived by the effectiveness of our blockade. That she will to some extent succeed may be conceded, for ordinary commercial conditions are no longer applicable to the case of a nation which has "its back to the wall," and is determined to stake everything, regardless of human life and treasure, in the struggle to preserve its existence. But whilst these attempts may do credit to the intelligence and resourcefulness of our enemies, and may serve to illustrate their undoubted organising capacity, they are clear proofs of the straits to which they are reduced.

Such attempts may prolong the duration of the struggle, but it is highly improbable that they will materially affect its ultimate result. It is possible that gun cartridges, rifle cartridges, and the fuse-heads of grenades may be made without the use of copper or brass, or with alloys containing only a minimal proportion of copper, but it is unlikely that such substitutes will prove as efficient as the material hitherto used. It must be remembered that the strongest arm of the enemy's service is its artillery, and anything that militates against the efficiency of that branch *pro tanto* weakens the enemy's power.

Supplies of cotton are almost unavailable to Germany and Austria; the closing of the Italian ports has effectively cut off some lines of importation of this commodity. Other sources of cellulose are, of course, open to them, and other forms of nitro-cellulose than ordinary gun-cotton are being made and are said to be in use with what is stated to be "unobjectionable" results, which rather sounds like damning with faint praise.

It is admitted that we have also cut off all supplies of petrol and petroleum, but as regards the use of the former substance in internal combustion engines, benzene, which is obtained by the destructive distillation of coal, is claimed to be a satisfactory substitute. This may be more or less true of ordinary motor-driven vehicles, especially in summer; but benzene is apt to freeze at low temperatures, and this circumstance has undoubtedly led to trouble in air-craft flying at high elevations in winter. Ordinary gasolene consists largely of pentane and amylene, and no doubt these hydrocarbons can be produced synthetically, if cost is no object. Indeed, it is claimed that German chemists have worked out two synthetic processes which are actually in operation, and are said to be so far successful that Germany is assured of internal supplies, even after the conclusion of the war. Acetylene has largely replaced petroleum as an illuminant, and is in use even in safety-lamps, and it is possible that the substitution may be more or less permanent, unless, which is unlikely, steps are taken on the conclusion of peace to reduce the relatively high price of burning oil consequent on the import duty and the operations of the American, Russian, and Dutch Trusts.

Germany also now claims to be independent of any external supply of nitrates. It is stated that "within a short time enormous works will have been erected, which will convert the nitrogen of the air into ammonia, and thence, by its combustion, into nitric acid"—one works alone turning out about 80,000 tons of nitric acid yearly. It may be confidently asserted that before this consummation is reached the war and all its doings will have been relegated to the domains of history.

Nitric acid can only be made commercially by the use of oil of vitriol, and there is ample evidence that the growing scarcity of the raw materials upon which the manufacture of the latter substance depends is causing great perturbation in chemical circles in Germany. All outside sources of sulphur, whether as such or as pyrites, are excluded. The use of sulphuric acid for the manufacture of fertilisers is practically prohibited. Attempts are being made to convert ammonium carbonate, obtained by the Haber process, into

ammonium sulphate by treatment with gypsum—a process already used in France with only partial success; and various methods of obtaining sulphuric acid from Epsom salts and other alkaline earth sulphates are being tried, with what probable result may be judged of from Lunge's well-known work on sulphuric acid manufacture, in which prior attempts to make use of such processes are described in more or less contemptuous terms. Indeed, the patent literature of every country is evidently being ransacked in the dire necessity which has now overtaken our enemies, and all sorts of suggestions, many of which have been tried and hitherto found wanting, are being exploited with a feverish activity.

The problem which confronts a Minister of Munitions in Germany is gradually becoming hopeless, unless he is given practically unlimited time in which to solve it. He has the men, who are working with a unanimity and a strenuousness which compels our respect and admiration, and the intelligence, knowledge, and skill of the captains of industry and all their appliances are at his disposal. But he cannot make bricks without straw, and the straw is gradually being denied him, struggle as he may. To us and to our Allies—thanks to our command of the sea—the world is all before us where to choose, and we have access to all the raw material we need. To our Minister of Munitions the problem is not want of material; it is want of men, and the lack of that strenuousness of purpose and of determination, energy, industry, and fixity of effort which have been imbued into the whole German nation. Time is of the essence of the situation, and to waste it in political bickerings, squabbles about profits and war bonuses, labour troubles, strikes, and "slackness" is to play directly into the enemy's hands and to prolong the agony and wretchedness under which the whole civilised world is now suffering.

EXPLOSIVES: ANCIENT AND MODERN.

Explosives: their Manufacture, Properties, Tests and History. By A. Marshall. Pp. xv+624. (London: J. and A. Churchill, 1915.) Price 24s. net.

IT is twenty years since any really important and comprehensive book on the subject of Explosives has been published in England, and the time was therefore ripe for a work that should bring the subject up to date and present it as a whole. In doing this, however, it is obvious that in such a wide and highly specialised field of work it is necessary to exercise the greatest care in selection and arrangement in order to avoid undue bulk of matter and at the same time to present the subject in the clearest possible way. This is the task that Mr. Arthur Marshall has set himself in "Explosives, their Manufacture, Properties, Tests and History," and the author has succeeded in giving us a most valuable book, which will be welcomed by all workers on the subject.

Part i. of the book is historical, and deals with the progress and development of explosives from Greek Fire to picric acid, and considerable space is given to Colonel Hime's translation of Roger Bacon's cipher instructions for the manufacture of gunpowder, and the reasons for supposing that the statements as to the great antiquity of gunpowder were inaccurate and based on erroneous translations. In this part of the book it is pleasant to find an appreciation of the wise and tactful manner in which Sir Vivian Majendie and his successors, Colonel Ford, Captain Thomson, Major Cooper-Key and their subordinates have carried out the working of the "Explosives Act" and have made it a boon to the workpeople without interfering with the development of the industry.

Part ii. is devoted to black powder, and three chapters are given to the preparation of the ingredients and manufacture, but nothing is said as to the reactions taking place on the firing of gunpowder under varying conditions, and although the products of explosion of R.L.G. powder as determined by Nobel and Abel are given, not a word is said of such historical researches as those of Bunsen and Schischkoff Linck, Karolyi and Debus.

Part iii. contains three chapters dealing with the manufacture of sulphuric acid and nitric acid, and the manipulation of waste acids. Although the preparation of nitric acid from Chile saltpetre is very fully described, the production of nitric acid from the air is dismissed in eight lines, which seems strangely inadequate in view of the Germans being at the present time largely dependent upon synthetic nitric acid for the preparation of their high explosives.

Part iv. is on the nitric esters of carbohydrates, and commences with a chapter on the Theory of Nitration of Cellulose, which gives the work done by many observers fairly fully, and then suddenly branches off to the commercial uses of pyroxylin and collodion. Following this come chapters on cellulose, manufacture of nitro-cellulose, stabilisation of nitro-cellulose, and the nitric esters of other carbohydrates.

Part v. deals equally fully with the nitric esters of glycerin, whilst smokeless powders occupy Part vi.

These first six divisions of the book contain

twenty-one chapters, and deal with the class of explosives that may be called "propellants." In reading them two criticisms arise—the first being that the subject matter is so subdivided as to destroy continuity, and the second is that a vast amount of detail as to manufacture and history of the explosives has been presented to the reader without any attempts being made to give an idea of the principles on which the composition and action of explosives depend. The explanation of this is probably to be found in the statement made in the preface that "subjects which are treated fully in the ordinary scientific or technical text-books have only been dealt with in so far as they throw new light on problems connected with explosives."

This limits the utility of the book, as although a collection of widely scattered results from many sources is a great help to the workers in the subject, the addition of a chapter in the early part of the book, dealing with the principles on which the subject rests, would have enormously extended the public to which the work would appeal.

The next portion of the book deals with blasting explosives, and in Part viii. we come to the properties of explosives, such as their physical character, the pressure and heat, power and violence of explosion, and a chapter on ignition and detonation.

Part ix. is devoted to special explosives, such as fuses, safety explosives and fireworks. The chapter on safety explosives gives an interesting account of the testing galleries to be found in the mining centres of various countries, and the procedure adopted for testing the liability of explosives to ignite mixtures of coal gas or methane and air, and also coal dust suspended in air. The whole chapter is so well done that it is a pity that the author does not point out more strongly that the class of explosives to which these methods of testing have given rise are safe in name only, as those in which nitroglycerin is the explosive basis are so diluted with carbonaceous matter as to give on explosion volumes of carbon monoxide, a poisonous and inflammable gas, whilst the ammonium nitrate class often contains so large an excess of this salt, used in admixture with trinitrotoluene or other explosive body as to give an excess of oxygen, which must always be a danger in a coal bore.

Part x. deals with stability, whilst in Part xi. materials and their analysis are fully discussed.

Throughout the thirty-six chapters in which the book is divided full references are given to the original memoirs from which quotations are made, whilst there is an appendix and an index of names as well as of subjects.

FEEBLE-MINDEDNESS.

Feeble-mindedness: its Causes and Consequences. By Dr. H. H. Goddard. Pp. xii + 599. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1914.) Price 17*s.* net.

THIS is the most recent American work dealing in an authoritative and scientific manner with what is now known in this country as mental deficiency. Some years ago Binet and Simon devised a method of classifying mentally defectives according to the degree of intelligence they had attained, comparing the results of certain tests with those obtained from normal children of various ages. Thus, mentality 4 means that the patient has attained the intelligence of a child aged four years. This classification is adopted throughout the present work, certain general terms being used in accordance with the American general classification on the same basis. Patients of mentality 1 or 2 are called idiots, those of mentalities 3 to 7 are called imbeciles, and those from 7 to 12 are called morons.

In some preliminary remarks respecting the relationship of feeble-mindedness to certain other social evils, the author quotes statistics or competent opinions which seem to show that at least 50 per cent. of criminals, prostitutes and paupers (inmates of almshouses), many ne'er-do-wells and some alcoholics are feeble-minded. It is also mentioned that 80 per cent. of truants are feeble-minded, the explanation being that truancy is the result, and not the cause, of failure in school-work.

The greater part of the book is devoted to the study of heredity in relation to feeble-mindedness. This investigation is so thorough that it comprises the labours of a whole field of trained investigators, for it is clear that no one man could carry out by himself the enormous amount of work recorded in Dr. Goddard's book. Not only is a detailed family history obtained, but as many members of the family as possible are personally seen and examined or, when this is not possible, inquiries are made of the inhabitants of the village where the person lived respecting his intellectual capacity. In this way a history is obtained of every individual member of the family tree for three, four, five or, in one case, six generations back. When we reflect how few of us could give particulars of so many of our ancestors, we can appreciate the amount of labour which has been expended in this field.

In chapter v. the author collects the data of his charts in a series of twenty-one tables and shows the etiological influence, positive or negative, of alcoholism; paralytic, epileptic, insane or syphilitic parentage or affection; tuberculosis; sexual

immorality; blindness and deafness; consanguinity; neuroses, etc. This chapter cannot be abstracted but, in the succeeding chapters, the author discusses the Mendelian law and its relationship to feeble-mindedness.

Dr. Goddard appears to be disappointed with his conclusion that *general intelligence* is a unit character, although several psychologists (Burt, Hart, Spearman and others) have amply demonstrated this truth from other points of view; and his figures agree so closely with Mendelian views that he feels justified in stating that "normal-mindedness is, or at least behaves like, a unit character; is dominant and is transmitted in accordance with the Mendelian law of inheritance." From this it is to be inferred that feeble-mindedness obeys the law as a recessive character.

Then comes a chapter on eugenics, in which the author states, in opposition to Mott, that feeble-mindedness does *not* tend to run itself out of a family, and considers that the stock might be improved if something were done on eugenic principles. Colonisation and vasectomy he regards as generally impracticable, and is rather inclined to some form of control of matings. Most people will regard this also as impracticable, at least in this country.

The book contains a mass of information to which no reference has been made in this review, and we have no hesitation in saying that it should be on the shelf of every statesman and asylum medical officer in the country.

There are some curiosities in spelling, such as "thot," "thotless," "thru," "thruout," "altho," and "tho"; but the book is good, the illustrations are good, the index is good, and we commend the author on an admirable production. The volume is well got-up and presents a dignified appearance, but it possesses the common American fault of being rather heavy for its size.

SYSTEMATIC NATURAL HISTORY.

(1) *Flora of Jamaica, containing Descriptions of the Flowering Plants known from the Island.* By W. Fawcett and Dr. A. B. Rendle. Vol. iii. *Dicotyledons: Families Piperaceae to Connaraceae.* Pp. xxiv + 280. Plates i–v, text-figures 1–113. (London: British Museum (Natural History) and Longmans, Green and Co., 1914.) Price 15*s*.

(2) *The Fauna of British India, including Ceylon and Burma. Mollusca*, ii. (*Trochomorphidae to Janellidae.*) By G. K. Gude. Pp. xii + 520, text-figures 1–164. (London: Taylor and Francis, 1914.) Price 20*s*.

(3) *Catalogue of the Amatidae and Arctiadae (Nolinae and Lithosianae) in the Collection of the British Museum.* By Sir G. F. Hampson. Pp. xxviii + 858, text-figures 1–276. (London: British Museum (Natural History) and Longmans, Green and Co., 1914.) Price 25*s*.

THE verse in which Catullus describes the three volumes of Chronica written by his friend Cornelius Nepos may well be applied to the three works above named, "Doctis, Juppiter, et laboriosis." Though by different authors, they agree in displaying the unwearied industry with which modern naturalists of eminence examine and re-examine, compare and classify, name and (occasionally) re-name, the objects which Nature, their patroness, offers in seemingly endless variety.

(1) The botanical volume is usefully illustrated by detailed figures for one species in each genus, and provided throughout with helpful keys for the discrimination of families, genera, and species. Here and there economic and other untechnical notes are introduced, as in the Annonaceæ, on what is good to eat or otherwise. A bibliography occupying several pages with more than two hundred entries is some evidence of exhaustive research, and credit is given to fifty-six collectors and contributors of specimens. This interesting list covers a period of more than two centuries, beginning with H. Barham as earliest and longest in the field (1680–1726), and concluding with Mr. and Mrs. N. L. Britton (from 1906) and Mr. J. R. Bovell (from 1914) down to the present time. As might be expected, there are many well-known names in the intermediate group; for example, Sir Hans Sloane in the seventeenth century, Patrick Browne in the eighteenth, Philip Henry Gosse in the earlier half of the nineteenth, and in the latter half Sir Daniel Morris (1879–1886), and William Fawcett (1887–1908), the last-named by his former position as director of public gardens and plantations in Jamaica being exceptionally qualified for the joint-authorship of the present flora. Charles Kingsley's visit to the West Indies did not include Jamaica, but his attractive volume "At Last" offers an observation that may well apply to it. Referring to West Indian weeds, he says:—

"So like home weeds they look: but pick one, and you find it unlike anything at home. That one happens to be, as you may see by its little green mouse-tails, a pepper-weed (Peperomia), first cousin to the great black-pepper bush in the gardens near by, with the berries of which you may burn your mouth gratis. So it is, you would find with every weed in the little cleared deli, some fifteen feet deep, beyond the gravel. You would not—I certainly cannot—guess at the name, seldom at the family, of a single plant."

Fawcett and Rendle state that there are more than six hundred species of Peperomia, and they carefully discriminate thirty-six species as occurring in Jamaica, in the distribution of five naming Trinidad, with which Kingsley was concerned. Unfortunately in their technical keys and descriptions they do not take into account "little green mouse-tails" as a distinguishing character! This omission does not prevent our perceiving how great a boon this work of theirs will be to all botanists, amateur as well as professional, to whom the West Indian flora makes any sort of appeal.

(2) and (3) Turning now to the zoological treatises, in two trifles, regarding not matter but mode, the reader may find Mr. Gude's volume better to his liking than its companions. Its alphabetical index is simple and continuous for genera and species, whereas the botanists less conveniently divide up theirs into a simple series for the genera, but for the species as many separate series as there are genera. Sir George Hampson's alphabetical index agrees in principle with Mr. Gude's, but parsimoniously omits several generic names altogether. Also, like the botanists, where no saving of space can be pleaded, he disfigures names of authorities by abbreviation, supplying such forms as Butl., Dogn., and the unpronounceable Wllgrn. and Hmpsn., to compare with the equally illustrious botanical writers Miq., Moq., and Mill., Ham., and Jacq., Nutt., Plum., and Tréc.

Sir G. Hampson reports that since the first and second volumes of the "Catalogue of Moths" were published in 1898 and 1900 respectively, to a total of 426 genera and 2401 species in one family and part of another, there have been added ninety genera and 1941 species, the monstrous increase dealt with in the present volume.

Similarly in Mr. Gude's work, the family of Helicidæ alone occupies nearly 200 pages, though far from covering the complete distribution of these familiar snails. In this subject the growing importance of malacology is ever tightening its grip upon conchology, the immediate effect being to expose earlier classification at many points to serious need of revision. An enthusiast in the eighteenth century, wishing to teach mankind how to estimate character by the curves and angles of the forehead, says, "For this purpose, I would advise the physionomist to procure a collection of sculls of well-known persons," evidently expecting that well-known persons would readily lend their skulls in the interest of scientific investigation. The modern student of mollusca wants, not so much the skull-cap so prized by the conchologist, as the molluscous body, to dissect out the radula with its ribbon of (often multitudinous) teeth, to examine the intimate parts of the hermaphrodite structure, and to note, it may be, as Mr. Gude has done in the genus Corilla, curious differences between immature forms and their parents.

Both our zoologists evidently intend to uphold the pedantic, inconvenient, and unscholarly rule that the specific name should agree in gender with the generic. The rule is unscholarly, because, while all sexual species of animals contain male individuals, the Latin tongue gives a preference to the masculine gender, where it has to do with genders in combination. The rule is inconvenient, because cases are continually occurring, as has been several times shown, in which naturalists are deceived as to the real gender of a generic name. Had he been content to leave specific names in the masculine gender, Mr. Gude would have been spared three out of the seven items of his list of errata. Yet in the body of the work he leaves *Pupisoma miccyla* (neuter and feminine) by the side of *Pupisoma cacharicum*, and, while himself using *P. constrictum*, quotes Godwin-Austen for *Pupa* (*Pupisoma*) *constrictus*. He treats *Zootecus* as masculine, though by its termination it should be regarded as neuter. In like manner among the moths we have the generic names Sphecosoma, Chionaema, Chrostosoma, Cosmosoma, Empyreuma, neuter forms, all treated as feminine, though apparently by accident *Sphecosoma nigrifer* escapes a change into *nigrifera*. Why the genus Mesothen, with a Greek adverb for sponsor, should be deemed feminine, remains obscure. But, apart from any grammatical mysteries, it remains clear that the several authors have applied much sound learning and solid labour to their very arduous tasks.

T. R. R. STEBBING.

OUR BOOKSHELF.

Ancient Hunters and Their Modern Representatives. By Dr. W. J. Sollas. Second Edition. Pp. xxiii + 591. (London: Macmillan and Co., Ltd., 1915.) Price 15s. net.

PROF. Sollas's treatise on prehistoric archæology having the title of "Ancient Hunters and their Modern Representatives" was published four years ago. We are not surprised to know that the first edition was soon exhausted, for the book was well designed to meet the needs of a large public. In the present edition the author has incorporated accounts of the more recent discoveries relating to ancient man, including Mr. Dawson's important find at Piltdown. Prof. Sollas had anticipated the discovery of such a form as Eoanthropus "as an almost necessary stage in the course of human development." He apparently differs from Dr. Smith Woodward as regards the antiquity and size of brain of

Eoanthropus, assigning this human form to the "latter half of the Pleistocene" and giving its cranial capacity as "at least 1070 c.c." Dr. Smith Woodward came to the conclusion that Eoanthropus belongs to the older Pleistocene, and in his more recent reconstruction of the skull represents the cranial capacity as 1300—230 c.c. above his original estimate.

Prof. Sollas sums up his final conclusion as regards human antiquity as follows: "that man, not only in the narrower, specific sense but also in the broader generic sense—Homo—is a product of the Pleistocene epoch, the latest child of time, born and cradled amongst those great revolutions of climate which have again and again so profoundly disturbed the equilibrium of the organic world." It will be seen from this extract that the author favours the older opinion that man made his first appearance at a comparatively recent date.

The Body in Health. By Prof. M. V. O'Shea and J. H. Kellogg. Pp. ix+324. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 3*s.* 6*d.*

Of the making of books on elementary physiology and hygiene there seems to be no end, and the tendency to the multiplication of such manuals is specially marked in America. Perhaps this is an indication that our cousins across the sea are more alive to the importance of health in the well-being of a nation; they certainly make it a much more universal subject of school education than we do. The present volume has much to recommend it; it is clear, convincing and accurate; it is written in simple language and well illustrated; as a rule it is level-headed. The usual space, as in all American text-books of this kind, is devoted to the evil of alcohol; with that one has no quarrel; but tobacco also is regarded as nearly equally bad. The following is, for example, quoted with approval: "I know whereof I speak when I say that tobacco when habitually used by the young leads to a species of imbecility; that the juvenile smoker will lie, cheat and steal things he would not do had he let tobacco alone." Extravagant superlatives of this nature often do more harm than good.

W. D. H.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Ultra-Violet Excitation of the D Line of Sodium.

In a letter on this subject published in Nature, May 13, I showed that sodium vapour, stimulated by the second line of the principal series at wave-length 3303 in the ultra-violet, fluoresces with emission of the D line, which is the first member of the principal series.

Each of these lines is a doublet. The interesting question arises, Supposing that stimulation were confined to one member only of the ultra-violet doublet, should we get emission only of the corresponding member of the D line, or would both components of the D line be emitted? The first alternative seemed *a priori* more probable, taking into account the result of Wood and Dunoyer, that if sodium vapour is stimulated by D light, one component of the D line is not able to give rise to fluorescent emission of the other.

I have, however, succeeded in carrying out an experiment which seems to decide fairly conclusively in favour of the second alternative. The zinc arc spectrum shows an ultra-violet doublet very near the sodium doublet. My attention was directed to this by reading Prof. Wood's account of his earlier attempts on the problem. Direct comparison of the spectra showed that the zinc doublet lay inside the sodium doublet, but that while one of the zinc components was situated at about one-twentieth of an Ångström from one sodium component, and thus very nearly in coincidence, the other zinc component was four times as far from its sodium neighbour, and well clear of it.

A zinc vacuum arc in quartz was used to illuminate the sodium vapour bulb, interposing the filter mentioned in the former paper, for the suppression of visible light. With currents of three or four amperes nothing could be seen. Increasing the current to six amperes, a faint emission of D light was observed. It was as yet too faint for spectroscopic examination, but was identified by the absorption methods described in the former letter. At 15 amperes, the light was bright enough for a specially designed spectroscope, and showed *both components of the D line in about equal intensity.*

The current was increased in successive tests to about 100 amperes. These large currents were only kept on for two or three seconds so as to avoid destroying the lamp. For this short time the fluorescence was not inferior in intensity to the light of a moderately salted Bunsen flame, and the components of the D line were seen very bright. The intensity increases very rapidly with the current through the lamp. This is due partly, of course, to the greater brightness, but more to the broadening of the first zinc component, which makes it definitely overlap the first sodium component. Possibly at very large currents this cause may even bring the second zinc component on to the second sodium component, but plainly the first overlap must come in much sooner, for the interval to be bridged is four times less; and at the lowest current which brings out the D line brightly enough for examination, its components are approximately equal.

Wood's failure to get any D emission is probably to be explained by his not having used a heavy enough current through the zinc lamp to secure an overlap of the zinc and sodium lines.

R. J. Strutt.

Imperial College of Science, South Kensington, May 31.

On the Sealing of Electrical Conductors through Glass.

At the present time there is great difficulty in obtaining soft glass with a comparatively high coefficient of expansion, suitable for sealing wires into glass tubes, bulbs, etc. The pre-war imported stocks of glass for this purpose are exhausted, and the recently published results of glass research committees do not contain formulas for its manufacture. About three years ago, Mr. George B. Burnside, of the natural philosophy department of the University of Glasgow, discovered a method of hermetically sealing electrical conductors through glass and other vitreous substances. The process is simple, and

entirely obviates the use of a "flux" glass; and in view of the present needs, it seems advisable to bring this method again before the notice of those who may find it to their advantage to use it. A general description of the process appeared in the *Electrician* of July 4, 1913; but the method does not seem to have become so popular as might have been expected from the simplicity and ease of its application. As to the results obtained, the following facts from my own experience may be mentioned as affording proof of its absolute perfection.

In the course of some research work which is being carried on at present in Prof. Gray's laboratory, involving the examination of certain resolved spectral lines, a Wehnelt electrolytic interrupter was used in connection with an 18-in. induction coil. This interrupter was employed on account of the fact that, with it, the discharge can be allowed to run for hours without attention. The positive electrode was simply a small length of platinum wire sealed through the end of a glass tube. The wire conveying the current dipped into mercury surrounding the upper end of the sealed wire. At first the sealing of the platinum wire into the glass tube was done by means of a "flux" glass in the usual way. It was noticed, however, that after a few hours' working, as a result of the disruptive action of the interruptions, this glass round the anode became pitted out, a crater being formed with the wire projecting from its centre. This action may go on until a leak occurs. Again, for the large currents used—more than 10 amperes—a fairly heavy wire is necessary, and the heating effect frequently causes fracture of the glass, by small radial cracks starting from the wire, or even from the junction of the two glasses. Both these effects are, of course, undesirable. The pitting out of the glass exposes a greater amount of the conducting material, and consequently alters the frequency; while leakage due to fracture considerably increases the amount of "steady current," that is, current spent in mere ordinary electrolytic effects.

To overcome both these defects, I used a piece of Jena glass tubing, with a small length of heavy platinum wire sealed directly into it by the Burnside method. This anode has been in use now for several hours daily for the past five weeks, and there is neither any fracture nor any sign of the pitting out of the glass as formerly. This hard glass is less liable than the soft sealing-in glass to be damaged by the disruptive action of the current, and the chilling process has the effect of toughening the skin of the glass as well as of perfecting the seal between the glass and the wire.

In connection with the same research, a large number of small vacuum discharge tubes were required. In most of these tubes, the electrical conducting wire has been sealed in by the Burnside process, and in every case the result has been entirely satisfactory. The spectral lines under observation are of rather low intensity, and, in consequence, exposures of four or five hours' duration are required to give a good photographic presentment. Generally, each tube has been used for two photographs. Thus the discharge has been passed in one direction for four hours or more, continuously, and then in the opposite direction, for a similar continuous period of four or five hours. In many cases, during the process of exhaustion, the tubes have been strongly heated by means of a bunsen burner; during some of the exposures, when the vacuum has been high, the tube has become very hot; in some cases the discharge has fractured the glass near the discharge end of the kathode; but in no single case has cracking occurred at the seal, nor has there been any sign of leakage. Considering the large number of tubes used, I think these facts afford striking evidence of the trustworthiness of the seal.

The essential part of Mr. Burnside's process of sealing consists of the repeated immersion of the leading-in wire and the glass surrounding it, in a bath of oil, fat, or wax. If a wire is to be led into a tube, the tube should be drawn down until the bore is just large enough to admit the wire. The conductor having been inserted, the glass around it is strongly heated in the blow-pipe flame until perfect cohesion has taken place between the metal and the glass. The wire should then be drawn out slightly, carrying the adhering glass with it, and this glass heated again. This may be repeated until a "neck" of glass about two or three millimetres long, and having the end well rounded, is formed around the wire. The seal is then withdrawn from the flame, and, when the red glow has entirely disappeared, the end of the tube carrying the wire is cooled by several immersions in the oil. This may best be done by bringing the bath containing the oil—a short, wide test-tube, say—up round the seal. Each immersion should last about two or three seconds. The depth of immersion is increased with each successive dip, until the seal is completely cooled out. In the case of vacuum tubes where the electrode requires a small inner support tube, the conducting wire can first be fused into the support tube, leaving a fairly long thick neck of glass in contact with the wire. This support is then well fused into the bulb of the vacuum tube in the usual way, and, finally, the seal is cooled out as described above. Not only does this cooling process render perfect the seal between the metal and the glass, but it also improves the junction of the glass of the inner tube with that of the outer. The leading-in wire of one of the vacuum tubes, immediately after being cooled out in oil, has been suddenly heated in the blow-pipe flame until it was at a bright red heat up to within about 1 mm. from the glass, without the seal being affected.

Compared with previous methods of sealing in electrodes, where a special "flux" glass had to be used, where care had to be taken to prevent the ordinary glass of the tubes from coming directly into contact with the metal, and where, unless special precautions as to annealing were observed, fractures frequently ensued, the present method is much simpler and easier, and more effective. It also enables us to make discharge tubes of Jena or other hard combustion glass. This was formerly quite impossible on account of the fact that no "flux" was known which was suitable for sealing wires through glass of this nature.

Mr. Burnside recommends that sperm oil be used, and that it be heated slightly before the glass is immersed in it. For the above work, I used the ordinary machine oil from the workshop—simply because it was most readily obtainable—and used it at room temperature. In cases where the position of the seal prevents its being conveniently immersed in a bath of oil, the process may be effected by bringing vertically upwards a piece of fat or wax cut to a suitable size and shape, and pressing it against the hot seal.

It may be mentioned also, that not only can platinum be sealed directly through Jena or other hard resistance glasses, and through fused quartz, but that perfect seals may be made between the more easily oxidisable metals, such as copper or iron, as well as platinum, and glasses having comparatively low fusion points, *e.g.* lead glass and German glass, or any glass of this nature. For large currents the conductor should be tubular, because it can be more

effectively cooled out by repeated immersions than would be the case if a solid conductor of the same cross-sectional area were employed.

The cases to which the process is applicable in scientific work are obvious and numerous, and it is needless to specify them. In view of the number of applications of a commercial and industrial value, as *e.g.* in the manufacture of incandescent electric lamps, mercury-vapour lamps, etc., the process has been protected by patent in Great Britain and abroad; but I understand that this protection is not intended to restrict in any way its use in research laboratories or its application to any purposes of a purely scientific and unremunerative nature. F. F. S. BRYSON.

Natural Philosophy Institute, University of Glasgow, May 24.

Eryonicus-Polycheles.

IN a recent publication on the Crustacea of Ireland, "Decapoda Reptantia of Ireland," Part I., by C. M. Selbie (Fisheries, Ireland, Sci. Invest., 1914, I. (1914)), the question of whether the peculiar forms known as Eryonicus are larvæ of the crayfish-like deep-sea crustaceans Polycheles is answered to the effect that they are independent animals constituting a genus related to Polycheles.

As these animals since the days of the *Challenger* Expedition have enjoyed a special interest as the modern survivors of a group almost until then believed to be confined to Jurassic and Cretaceous times, I thought it might possibly interest some of your zoologist readers to learn about some of the results obtained through the study of the material collected in the North Atlantic by the *Michael Sars* in 1910 during the cruise undertaken by the late Sir John Murray and Dr. Johan Hjort.

To begin with, it must be mentioned that the best specific characters both in Polycheles and Eryonicus are derived from the arrangement of the spines on the carapace. Now a peculiar correspondence is observed in several species of the two "genera," making it possible to "pair" several of the Eryonicus species each with one of the Polycheles species, as will be seen from the following formula representing the position of spines in the median line of the carapace. In these formulæ, 1 and 2 denote single and double *pointed* spines, while 3 denotes a single *blunt* spine, and *c* the position of the cervical groove, the rostral spines being to the left:—

E. faxoni, Bouvier	2.1.2.1.3.*c*.2.2.3.2	*a*
P. sculptus, Smith	2.1.2.1. *c*.2.2. 2	
E. coecus, Faxon	2.1.2.1.1[1].*c*.2.2.1[1].2	*b*
P. sculptus pacificus, Faxon	2.1.2.1. *c*.2.2. 2	

The two species *a* live in the Atlantic, the species *b* in the Pacific. The only difference between the two pairs consists in *b* having a spine on the cardiac area on each side, this spine being absent in all specimens of *a* examined by Mr. Selbie and myself:—

E. hibernicus, Selbie... ...	2.1.1.2.3.1.*c*.2.2.3.2	*c*
P. nanus, Smith...	2.1.1.2. 1.*c*.2.2. 2	
E. spinulosus, Faxon ...	2.1.1.1.2.1[1].1[1].*c*.2.2.1[1].2	*d*
P. tanneri, Faxon	2.1.1.1.2. *c*.2.2. 2	
E. kempi, Selbie...	1.1.1.1.2.1. *c*.2.2.3.2	*e*
P. typhlops, Heller	1.1.1.1.2.(2)*c*.(2).(2). 2	

The figures within brackets in the formula for *P. typhlops* denote that these spines in some of Mr. Selbie's specimens were of reduced size, single, or wholly rudimentary. It will be noted that the spines known or supposed to be blunt have no equivalent in the corresponding Polycheles.

[1] These spines are represented by Faxon as being pointed. I believe from analogy with all the Irish and *Michael Sars* specimens that they are in fact blunt.

Now, I ask, is it possible to explain the above correspondences as mere accident, or are they not to be taken as evidence of the Eryonicus species being in fact larval Polycheles?

One of the commonest objections to this theory is the giant size presented by some of the Eryonicus-specimens compared with the smaller Polycheles-individuals, though this need not signify much. Like so many other plankton animals, the Eryonicus are of a nearly jellyfish-like consistency, and it may as well be conceived that an Eryonicus can shrink into a small Polycheles, as that the Leptocephali, when turning into "montée," lose about 78 per cent. in weight (in dry matter they lose over 32 per cent.), according to Dr. Johs. Schmidt, the Danish specialist on eels.

If Eryonicus were adult animals, it would be rather remarkable that not a single egg-bearing female has been found among the fifty-nine specimens known to have been captured (Mr. Selbie, *op. cit.*, mentions thirty-five specimens, and the *Michael Sars* got twenty-four). It cannot matter much that secondary male sexual characters in different stages of development have been found in a few of the largest specimens.

Finally, it must be mentioned that one is at a loss where to seek the larvæ of Polycheles, which do not seem to be very rare animals (the Irish research steamer *Helga*, for instance, obtained thirty-two specimens) if these larvæ are not represented by Eryonicus.

For literature and details of the species in question, see Mr. Selbie's paper quoted above.

OSCAR SUND.

Bureau of Fisheries, Bergen, Norway, May 8.

The Age of the Earth.

IN NATURE of May 6, Mr. C. E. Stromeyer states that two conclusions in my letter published in your issue of April 22 are not correct; he claims, first, that the amount of energy lost by the earth is not compensated by the heat received from the sun; secondly, that meteoric bombardment of the sun has been left out of account as a source of energy.

As to the first point, the amount of energy lost in consequence of the temperature gradient in the earth's crust is of the order $1{\cdot}33\times10^{-6}\frac{\text{cal}}{\text{cm.}^2\text{sec.}}$. As this is 6000 times less than the total amount radiated, no useful purpose would be served by taking it into account.

As regards the second point, any heat due to meteoric bombardment up to date has been taken into account, as the sun's mass as it is known to-day was inserted in the calculation.

Perhaps the purport of my letter was not as clear as I could have wished. It was not so much my intention to weigh the evidence for or against an age of some twenty million years, as to emphasise the point that neither radio-activity nor any other known cause will account for a longer period. I have lately had the advantage of discussing the subject with Prof. Strutt, and must admit that the conclusions he has drawn from the helium contained in rocks appear unanswerable.

It would seem, therefore, that the origin of the sun's heat cannot be referred to any known cause.

Farnborough, May 15. F. A. LINDEMANN.

Modern Substitutes for Butter.

THE issue of NATURE dated April 8 contains an article relating to "Modern Substitutes for Butter," which gives a highly interesting impression of the technical and scientific state to which the margarine industry has developed in recent years.

Towards the end of the article, the author deals with the influence of vitamines, and indicates that, while these substances are present in butter, they would not be met with in margarine

This characteristic would meet the case as regards certain butter and margarine products, but by far the largest quantities of butter now on the market are made from pasteurised cream, and the pasteurisation would no doubt have reduced the original quantities of vitamines very considerably.

On the other hand, large quantities of margarine contain, among other fats, cold-pressed oils (such as ground-nut oil) which, like the better grades of olive oil, do not undergo any refining process whatever, and would therefore lend to the margarine their original content of vitamines.

If vitamines are produced in the lactic acid fermentation of milk, an abundance of these precious substances would be imparted to both butter and margarine, as in buttermaking the ripening takes place after the cream has been pasteurised, and in the manufacture of margarine the ripened skim milk is churned with the fat after the latter has been refined. Hence in both cases the vitamines produced in the fermentation process are not subsequently subjected to any harmful treatment.

It therefore appears that, so far as the presence or absence of vitamines is concerned, margarine would rank as equal to butter. There are, in fact, qualities of margarine on the market which contain a small proportion of fresh egg yolk, and such qualities would doubtless be of high standing as regards vitamines.

S. H. B.

So little is at present known about vitamines that "S. H. B." may well be correct in assuming their presence in cold-pressed oils, in ripened skim milk, and in fresh egg yolk. Even hot-pressed oils have probably not been subjected to such a temperature as to kill the vitamines.

On the other hand, if the present writer's memory is not at fault, the work of American investigators has shown that of several oils investigated, butter fat alone contained vitamines. There is also evidence to indicate that vitamines are closely associated with lipoids, and it is doubtful whether they would be formed during lactic fermentation. It is evident should vitamines be present in nut oils as suggested, that nuts might form a valuable preventative of beriberi, or scurvy; the writer is unaware if this has been tested in practice.

As stated in the original article, probably sufficient vitamines are present in the rest of the dietary to enable them to be dispensed with in the fat.

THE WRITER OF THE ARTICLE.

May 20.

THE EXTINCTEUR AND ITS LIMITATIONS.

THE portable chemical fire-extinguisher, better known as extincteur, has been much before the public of late. Leaving aside the whole of those unfortunate appliances that belong to the dry powder class and the glass hand grenade type, which are entirely untrustworthy, the portable chemical fire-extinguisher in modern practice may be looked upon as a cylinder of from 2 to 3 gallons' capacity, containing water, with the addition of some substance which may, or may not, add to the efficiency of the extinguishing power of the water discharged.

There are, of course, one or two other forms of portable chemical liquid fire-extinguishers, *i.e.*, certain forms of less than a gallon capacity containing carbon tetrachloride or some combination thereof, intended for use on small petrol fires, and where the capacity is sufficient, say, from 2 quarts to 1 gallon, and the chemical is discharged automatically by some capsule of compressed air or the like, effective results are obtained from such appliances on small spirit fires. Where, however, the appliance only has the capacity of a pint or quart of carbon tetrachloride or some combination thereof, and has to be applied by manual action, the limit of effectiveness is certainly very small, a quart of chemical applied, say, by a double action squirt being able to deal at the most with a 2 gallon tin of petrol spilt over a motor-car or in some vessel of no great area. A weak spot in the use of carbon tetrachloride and its combinations, by the bye, is the fumes it gives off when in contact with fire. For this reason its use in enclosed spaces should in any case be avoided, and people suffering from liver complaint should in any case keep clear of this chemical when used on fires.

But to revert to the ordinary portable chemical liquid extinguisher of 2 to 3 gallons' capacity, as seen in many public buildings, and thus considered by the general public as something acceptable for every-day purposes. We are desirous of warning the public as to unsuitable purchases of such appliances. To begin with, in a very general way a portable liquid chemical fire-extinguisher is not the alpha and omega of first-aid fire-extinguishing, although there is no doubt that these appliances as such are popular. They look so bright and neat. Their presence advertises the owner's forethought. If finished on copper they are quite ornamental.

For the ordinary householder and for the ordinary business establishment where fire appliances are not under constant inspection, we would, however, rather pin our faith in the ordinary bucket of water energetically applied, and the ordinary miniature manual hand-pump or corridor engine. A few dozen buckets and a couple of hand-pumps, involving together perhaps an expenditure of 5*l.* to 6*l.*, will work wonders in a quite substantial fire, whilst the same 6*l.* will only produce three or four 2-gallon extinguishers, which require, as a rule, practice to discharge properly and time to re-charge at intervals; they require also most careful maintenance, and at the best will give the user some 6 or 8 gallons of chemically prepared water as against, say, the 50 gallons of water immediately available for continuous application and rapidly replenished without intervals. A small stirrup hand-pump of the London type, by the bye, can be worked single-handed to supply 4 to 5 gallons per minute at an effective range of 25 to 40 ft.

The whole principle of putting out a small fire is the cooling effect of water applied in fair bulk continuously and under pressure; and the cooling effect can be best obtained by a copious supply

of water continuously applied in fair force and bulk from buckets and hand-pumps. The possibility of applying water in bulk continuously with a good cooling effect cannot be obtained from the ordinary householder's supply of extinguishers.

Of course, in public buildings where there are many extinguishers immediately at hand, where they are thoroughly maintained, and are handled by skilled or trained men, they are most useful. They are the most handy of water economising minor fire appliances in the hands of a professional fire brigade, although we observe the London brigade only used them in 577 instances last year, whilst they used buckets in 1248 cases. They are essential makeshifts for conditions where buckets and hand-pumps cannot be equally well stowed or applied, as, for instance, on trains, in small boats, or for other awkward places, as, for instance, on the aeroplane in flight, but, to repeat, the alpha and omega of fire extinguishing is not to be found in the extinguisher for the ordinary man in the street. His *vade mecum* should be the bucket and hand-pump, although they are less showy.

These observations, however, should not preclude the purchase, and, in fact, should not discourage the purchase of well-made mechanical portable liquid fire-extinguishers, where there is a probability of their being properly maintained and looked after, as, for instance, in public and semi-public buildings, in large industrial establishments, or estates having private fire brigades, etc., especially if their attempted application can be immediately followed by the application of a hydrant or fire engine. In such places, if of good make in the first instance, and regularly looked after, they are neither likely to burst and injure the operator nor are they likely to get clogged up and fail at the critical moment. The danger of bursting is no small danger, and has resulted in fatalities as well as many personal injuries, whilst in the large majority of establishments where these appliances are not properly looked after they will be found defective at the time they are to be used.

Thus at the initial stage of purchase, some standard as to safety for extinguishers is essential to limit the risk of careless users. It is very much to the credit of the British Fire Prevention Committee, to whose work we have had frequent occasion to refer, that it has for some years been pressing towards obtaining a sound standard of manufacture in chemical fire-extinguishers, and that it has further succeeded in getting these standards adopted as necessary standards by the Government and other principal purchasers at home and in the colonies.

One of the first results of the Committee's propaganda in 1911–12 was that the fire insurance companies early in 1913 adopted an American specification which had been long in force in the United States, and started listing extinguishers that complied with this form. The American model, however, being insufficient for British conditions, the British Fire Prevention Committee, which had been making exhaustive tests both with new appliances and appliances in actual use, issued its own provisional specification later in that year, which form was immediately adopted by several authorities of importance in their purchases. Extinguisher construction accordingly commenced to improve.

Next, the Fire Prevention Committee suggested some form of conference with the Government departments on the matter, so that the Government departments might be specifying either on the committee's provisional specification or some similar—preferably stronger—specification. The result of this conference has been that, in turn, H.M. Office of Works last summer, the Metropolitan Police last autumn, the Board of Trade this March, and other departments have either issued their own specifications, which are now practically identical, or have adopted the improved form of the British Fire Prevention Committee's specification of January 1, known as the 1915 standard. The only corporations which still keep to the lower standard are the insurance companies, but no doubt they will also come into line as time goes on, whilst in the meantime they benefit from the fact that the more responsible makers are now all making their appliances to either the Fire Prevention Committee's 1915 specification or to those of the Government departments named. The recent War Office contracts, for instance, are all for extinguishers to the Office of Works' specification, whilst half-a-dozen other departments are specifying their war emergency supplies to the Committee's schedule.

A point has, of course, been made by the traders that the existence of several specifications makes it difficult for makers to keep suitable stocks, but this is not the case in actuality, inasmuch as it will be found that any maker who will stock cylindrical extinguishers made to the 1915 specification will meet the requirements of either one of the authorities and the committee.

All this, of course, touches the great corporations, the great public authorities, and the public when using establishments controlled by public authorities, be they theatres, factories, or the like. The misfortune, however, is that the general public, the householder, the ordinary estate-owner, the ordinary motor-car owner, etc., are still subject to the cheap-jack extinguisher and the specious tout who sells nothing more than a dangerous "tin can" at an exorbitant price—a can which probably costs somewhere around 10*s.* to manufacture, and for which he asks anything he can get—frequently as much as 2*l.* to 3*l.*

It is an open secret that the best-made chemical fire-extinguishers can be produced in large quantities and sold according to external finish, and after allowing for a fair profit, from, say, 17*s.* to 20*s.*, to comply with the specifications named, and they should thus be obtainable in lesser quantities of handsome finish at 25*s.* or less. The whole myth of purchasing extinguishers at prices varying from 2*l.* to 3*l.*, holding 2 gallons of liquid, gaudily furbished, is bad enough when the

appliances are made to the best of specifications, but that they should be sold at these ridiculous prices when they are of the distinctly dangerous tin-can type, liable to burst easily, is very near fraud.

It is to be hoped that the British Fire Prevention Committee will persevere in its propaganda and obtain legislation after the war is over, making it a penal offence to construct an extinguisher unless there are certain constructional safeguards to be settled from time to time by the Secretary of State as mechanical science advances. Good progress has already been made in this direction, and but for the war, the protection of the public against fraudulent fire appliances might have already been achieved.

To our readers, however, this article should serve as one of warning to insist on a written warranty before payment for any extinguishers purchased, that it complies either with the British Fire Prevention Committee's specification, or with those of the Board of Trade, H.M. Office of Works, or the Metropolitan Police. Further, for the best finished article they should not pay more than 25*s*. to 30*s*. when constructed to either of these specifications, but if in doubt as to the machine offered or the possibility of regularly testing and re-charging it, let them keep to the old bucket of water and hand-pump. They at least are trustworthy, and the most suitable for ordinary conditions.

RESEARCH IN AERODYNAMICS.[1]

THE work of the Aerodynamical Laboratory at Koutchino is less affected by the necessity for technical work than any other of the European laboratories. It is for this reason, in all probability, that the latest bulletin makes a refreshing change from the publications of Eiffel and the Advisory Committee for Aeronautics.

The production of miniature whirlwinds forms the subject of one series of experiments, and the results are illustrated by some very interesting photographs. Rotations, as apart from eddies, are of frequent occurrence in nature; they may be seen in the autumn by the movement of leaves, due to a wind over open ground. Similar movements of air are found on the floor of the room below the intake of a wind channel, and the phenomenon indicates how little we really know of the motion of real fluids.

Perhaps the most interesting papers in the bulletin are two relating to the principle of dynamical similarity as applied to viscous fluids. Experiments with the same object were made by Osborne Reynolds, and recently Messrs. Stanton and Pannell have established the practical utility of the theory in the case of air, water, and oil flowing through pipes.

One of the two papers above mentioned deals with experiments on the surface friction of discs in air and water, the motion being one of rotation in their own plane. The agreement between theory and practice is complete. The second paper relates to the whole of the published information on the resistance of spheres in air and water, the results being very discordant amongst themselves. The conclusion is drawn that the conditions of the theory of dynamical similarity cannot in this case be satisfied experimentally with the necessary degree of exactitude. The results of the two papers are illustrated by Figs. 1 and 2. The first relates to the friction of discs, and in carrying out these experiments variations were made in three quantities of primary importance, the diameter and speed of rotation of the disc and the viscosity of the fluid. The ratio of the greatest diameter to the least was 10 : 1, the ratio of the extreme speeds 2 : 1, and the ratio of the kinematic viscosities 13 : 1. The theory of dynamical similarity indicates that any one of these changes can be predicted from the effect of changes in either of the others, and the practical proof of this is the fact that the whole of the experimental results can be collected on a single curve as in Fig. 1. As the range of variation included a region of critical flow, as indicated by the dip in the curve, the practical agreement is a delicate test of the exactness with which the experimental conditions complied with the conditions of geometrical similarity.

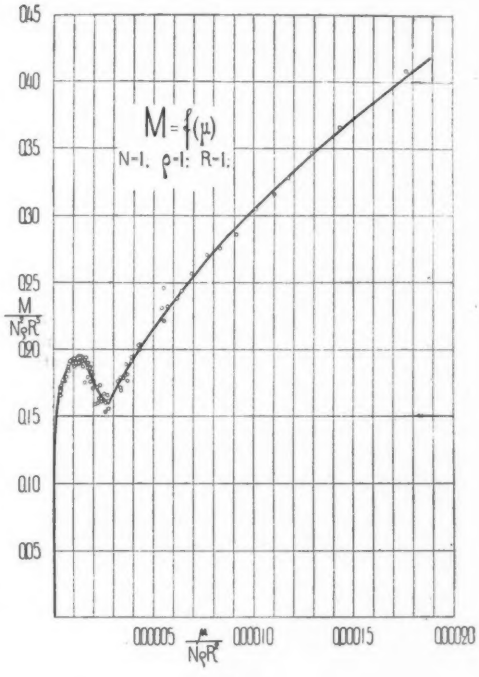

FIG. 1.

[1] Bulletin de l'Institut Aérodynamique de Koutchino. Pp. 296. Fascicule v. (Moscow: I. N. Kouchnéreff and Co., 1914.)

The reverse picture is shown in Fig. 2. The principle of dynamical similarity applies as rigidly to the resistance of spheres as to the surface friction of discs, but the experimental results vary very widely over almost the whole of the experimental range. An interesting contribution on the reasons for such large experimental discrepancies is made by Prof. Prandtl, who showed that a wire of small diameter put round a sphere in an appropriate place had the somewhat surprising effect of reducing the resistance to about one-third of that of the smooth sphere. It was further shown that a gauze screen introduced into the air current immediately in front of the sphere had a similar effect. The conclusion appears to be justified that the flow of air round a sphere is so very sensitive that small departures from strict geometrical similarity and from the condition of uniform relative motion are sufficient to account for the large experimental variations.

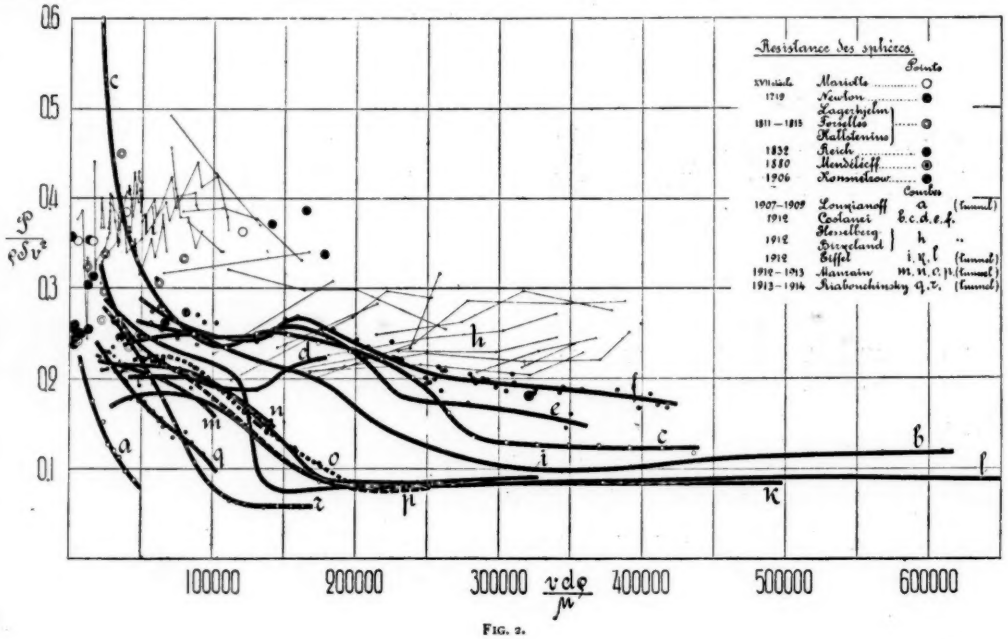

FIG. 2.

Further experiments are needed to clear up the position, but, obviously, no investigation can alter the fact that the resistance of a sphere must always be difficult to predict, except in very favourable circumstances. The possibility at least exists that the rough surface of a golf-ball has a very close relation to the instability of flow referred to, the advantage of the roughened surface being so great as to render it obvious in the direct test on the golf links.

It is fortunate for the future of aeronautics that similar troubles do not occur in connection with the important parts of an aeroplane, though an approach to such sensitivity has been found in the case of the fluid motion round certain struts.

DR. HUGO MÜLLER, F.R.S.

THE death of Hugo Müller will be greatly deplored by all who knew him—he was one of those few men who only make friends and at once inspire regard in all who are brought into contact with them. He died suddenly, at his country home, at Camberley, Surrey, in the early hours of Sunday, May 23, in his eighty-second year. Though very deeply distressed by the war, he enjoyed his usual good health to the last; in fact, he was in his garden until late in the evening on the previous Saturday and had worked in the Davy-Faraday laboratory up till Friday afternoon. He was buried at Brookwood Cemetery on Thursday last alongside his old friend Dr. Atkinson.

He was born at Tirschenreuth in the Oberpfalz. He was educated as a chemist at Leipzig, at Göttingen under Wöhler and at Munich under Liebig; but he also took special interest in mineralogy and was an ardent collector of minerals in his early days. It is clear that he was a precocious worker, as he described the geognostic-mineralogical features of his home district in 1852 in the *Regensburg Corresp. Blatt.*

He came to this country sixty years ago, on the recommendation of Liebig, as assistant to Dr. Warren de la Rue. Their first joint work involved the examination of Burmese naphtha at a time when very little was known of the petroleums. But they took up a variety of subjects and one of their most valuable contributions was the well-known chloride-of-silver-zinc constant battery which they devised. Dr. Müller also worked with

Stenhouse. His most noteworthy early discovery perhaps is that involved in the use of iodine as a catalyst in chlorinating. He was an intimate friend of Kekulé when the latter was in London.

A man of great personal charm of manner, of sympathetic nature and very versatile, he inspired confidence not only by the breadth and accuracy of his knowledge but also by his calm and clear judgment. His worth was soon recognised, so that he was consulted constantly by the firm of De la Rue and Co. long before he was induced to give up science and enter upon an industrial career in its service; ultimately he became a partner in the firm and remained in it until 1902 The Stamp department was his chief charge; in this he found full opportunity for the exercise of his scientific ability and great technical skill as well as of his artistic gifts. He was elected a fellow of the Royal Society in 1866. He joined the Chemical Society in 1859; he was its foreign secretary from 1869 to 1885 and president in 1885–87. He was a Ph.D. of Göttingen, an LL.D. of St. Andrews and a D.Sc. of Manchester. He became naturalised thirty-seven years ago, on his marriage to an English lady. He had two daughters, one of whom and his wife survive him.

When the Lawes Agricultural Trust was constituted by his old friend Sir John Lawes twenty-six years ago, he was appointed a representative of the Royal Society on the Committee and became the treasurer; he held the office until the present year, when he retired, in spite of the urgent requests of his colleagues that he would not sever the connection; but he thought that German residents in this country, whether naturalised or not, were so seriously affected by the outbreak of the war that it was not desirable that a person in his position should be a member of or take part in the affairs of any public concern or enterprise. He consistently remained aloof from everything.

Although his time was fully occupied by his business avocations while in the firm of De la Rue and Co., he never lost his interest in his science; since his retirement he worked regularly in the Davy-Faraday laboratory of the Royal Institution. The work he did, which has been published by the Chemical Society, is remarkable as proof of his exceptional skill as a manipulator and of special value to science. Only recently he completed the investigation of the peculiar bloom which appears on the leaf and flower-stalk of a number of species of primula; he made the striking discovery that this consists of flavone, the parent substance of the great group of yellow colouring matters present in plants, a substance only prepared in the laboratory previously.

Dr. Müller was also a noted horticulturist and botanist; he was long an active member of the scientific committee of the Royal Horticultural Society. Beginning thirty years ago with a sandy waste at Camberley, Surrey, he developed one of the most remarkable and beautiful gardens in the country. His knowledge of plants was quite exceptional, as it had long been his habit to grow them in order that he might know them; his garden, therefore, was always of special interest.

A man of large and noble mind, he was torn with distress by the outbreak of the war, which he looked upon as a downfall of civilisation; he deplored his having lived to see it and there is little doubt that his end was greatly hastened by recent events.

DR. M. W. CROFTON, F.R.S.

DR. M. W. CROFTON, whose death was recently announced in NATURE, was born in Dublin in the year 1826, the son of Rev. William Crofton, of Sligo, a clergyman of the Established Church. Together with his brother Henry, who was two years his junior, he entered Trinity College, Dublin, in the year 1843 under the tutorship of Dr. Graves, who afterwards became professor of mathematics in the college, and later Bishop of Limerick. Diligent students both brothers must have been, for at the moderatorship examination in 1847 Morgan, who had captured on the way all the undergraduate prizes open to him, came out first of his class in mathematics, while Henry headed the list in classics, a double event rare, if not unique, in the history of the College.

When the Queen's University of Ireland was established, Dr. Crofton was appointed professor of natural philosophy at Queen's College, Galway, a position which he resigned in 1853 after three years' occupation. He was afterwards professor of mathematics and mechanics in the Royal Military Academy, Woolwich, from 1870 until 1884, and on his resignation was appointed to a fellowship of the Royal University of Ireland, retaining that position until 1895. Dr. Crofton published a treatise on the "Elements of Applied Mechanics" (London, 1881), and contributed several papers on geometry and mechanics to various journals, but his chief interest was in the mathematical theory of probability. There is a paper of his in the *Phil. Trans.* of the year 1868 "on the theory of local probability applied to random straight lines," and another in the *Phil. Trans.* of 1869 "on the proof of the laws of errors of observations." He wrote also the chapter on mean value and probability in Williamson's "Integral Calculus," and the article, "Probability," in the ninth edition of the Encyclopædia Britannica.

Dr. Crofton was elected a Fellow of the Royal Society in 1868. S. B. KELLEHER.

NOTES.

WE notice with much regret the announcement of the death, on May 31, in his eighty-first year, of Sir A. H. Church, K.C.V.O., F.R.S., formerly professor of chemistry in the Royal Academy of Arts.

MEN of science view with especial satisfaction the appointment of Admiral Sir Henry Jackson, K.C.B., F.R.S., as First Sea Lord of the Admiralty. So far as we are aware no precedent exists for the nomination of a fellow of the Royal Society as First Sea Lord of the Admiralty. Born on January 21, 1855, Sir Henry entered the Navy at thirteen, became Lieu-

tenant of the *Active* during the Zulu war of 1878–9, and was promoted Captain in 1896. He afterwards became Assistant-Director of Torpedoes (1902), Controller of the Navy (1905), and Chief of the War Staff at the Admiralty (1913–14). In science Sir Henry Jackson's work refers chiefly to electrical physics. In the 'nineties of last century he was among the first to engage in the practical application of electric waves transmission; in other words, wireless telegraphy. He early made the acquaintance of Mr. Marconi, the two collaborating in important researches. In 1895 Sir Henry began systematic experiments and trials under sea-going conditions (inclusive of the use of balloons and kites), with the view of utilising the effect of Hertzian oscillations for naval signalling purposes. The results were embodied in a paper read before the Royal Society, entitled "On Some Phenomena Affecting the Transmission of Electric Waves over the Surface of the Sea and Earth." From 1905–6 he was A.D.C. to King Edward VII.; in 1906 he was made K.C.V.O., and, in 1910, K.C.B. The Royal Society elected him into its fellowship in 1901. A member of the Institution of Electrical Engineers, and an associate of the Institution of Naval Architects, Sir Henry also serves on the general board of the National Physical Laboratory, and has consistently promoted its interests in official quarters. It may be of interest to give the names of those fellows on the Royal Society's current list who either are naval men or are engaged on Admiralty service. They comprise Admiral Sir A. M. Field, late Hydrographer; Capt. T. H. Tizard, late Assistant-Hydrographer; Sir Henry J. Oram, Engineer Vice-Admiral, Engineer-in-Chief of the Fleet; Capt. E. W. Creak, C.B.; Sir Philip Watts, late Director of Naval Construction; Mr. R. E. Froude, Superintendent of the Admiralty Experimental Works at Gosport; Sir J. A. Ewing, Director of Naval Education; Sir John Thornycroft; and the Hon. Sir Charles Parsons.

WE learn from the *Scientific American* that Mr. Walter G. Davis, director of the Argentine Meteorological Service, recently retired on a pension, and was succeeded by Señor Martin Gil, described in the Argentine newspapers as a wealthy amateur meteorologist and astronomer, much interested in long-range weather prediction.

A WAR Exhibitions has been organised to assist the funds of the Belgian Red Cross Anglo-Belgian Committee, whose patroness is the Queen of the Belgians. The exhibition is designed to present an idea of the extent to which science and industry are being utilised in every branch of the present gigantic struggle. The exhibition comprises seven sections, which include, with others, armament and ammunition in the making, Red Cross work, science and industry applied to war, food and hygiene, and a maritime and aerial section. The exhibition will be held at Prince's Skating Club, Knightsbridge, London, from June to October.

DURING a thunderstorm near Gibraltar on May 25 a cloud is said to have belched forth millions of small frogs which had apparently been drawn up from a lake twenty miles away. Such "showers of frogs," when satisfactorily authenticated, are to be ranked along with showers of sticklebacks, herring, and even larger fishes. Some of these showers are well vouched for, and admit of physical interpretation. In an eddy of a whirlwind there is sometimes draught strong enough to suck up dust and leaves and sheaves, or water and fishes and frogs. The whirling column is borne on by the wind and may transport its burden for many miles until the rotational energy is expended and the little tornado is over. It must be carefully noted, however, that the sudden appearance of multitudes of small frogs often implies nothing more than the usual migration of the young frogs from their birthplace in the pond to their summer quarters in the fields. Similarly, as Gosse pointed out long ago, alleged "snail showers" are apt to disappear under scrutiny, and "a torrent of periwinkles" turns out to be a migration of *Helix virgata* or the like. In his "Romance of Natural History" Gosse inquired in a fair-minded way into the various kinds of animal "showers," and came to the conclusion that some of the records were worthy of credence as regards frogs, toads, and fishes. It is probable enough, then, that the Gibraltar shower was genuine.

A REMARKABLE discovery of flint implements has been made recently at Highfield, Southampton, and a large selection of them is now displayed in two new cases in the prehistoric section of the County Historical and Antiquarian Museum at Tudor House. The spot where they were found is apparently the site of the workshop or cache of a Palæolithic master-craftsman in flint, and great numbers of implements in various stages of fashioning were brought to light on a limited area. The series shown covers the whole technique of manufacture, from the roughly-shaped-out slabs of table flint to beautifully chipped and completed implements, with their edges still unabraded. It includes blanks or shaped forms of flint cut with astonishing precision, portions of implements broken in process of making, chips, etc. Some of the smaller implements vie in beauty of workmanship with the fine products of Neolithic culture, and are also of shapes generally associated with the later Stone Age, though their gravel patina is indisputable proof that they came from the river drift, and so are of Palæolithic origin. Series of both large and small implements, the latter including various forms of scrapers, arrow-points, etc., are shown in their different stages of making, so that the processes of manufacture become clear to the student. It is worthy of recording that the surface soil of the site yielded some interesting Neolithic implements, which are also shown.

STONEHENGE, the most remarkable of our national prehistoric monuments, is included in the Amesbury Abbey estate, Wiltshire, which is to be sold by auction in September. Much information about this notable structure and its significance will be found in Lady Antrobus's "Sentimental and Practical Guide to Amesbury and Stonehenge" and Sir Norman Lockyer's "Stonehenge and other British Stone Monuments Astronomically Considered." The first British author who is considered to make unmistak-

able mention of Stonehenge is Henry of Huntingdon (twelfth century). He refers to it as the second wonder in England, and calls it Stanenges. Geoffrey of Monmouth (A.D. 1138) wrote of it about the same time, as did also the Welsh historian, Giraldus Cambrensis. The outer circle of thirty upright stones has a diameter of about 100 ft. These stones formerly stood 14 ft. above the surface of the ground. Within this peristyle there was originally an inner structure of ten stones arranged in the shape of a horseshoe formed of five (but some think seven) huge trilithons, which rose progressively in height from north-east to south-west, the loftiest uprights being 25 ft. above the ground. About one-half of these uprights have fallen; during the operations connected with the raising of one of the uprights in 1901 numerous flint axe-heads and large stone hammers were found at a depth of from 2 ft. to 3 ft. 6 in. underground—all tending to prove the great antiquity of the monument. From his investigations of the orientation of Stonehenge, upon the assumption of the structure having been erected as a solar temple, Sir Norman Lockyer concluded that the date of its foundation was 1680 B.C.

WE regret to learn of the death of Dr. Aksel S. Steen, director of the Norwegian Meteorological Institute, and fellow of the Norwegian Academy of Sciences. Dr. Steen was for many years assistant director of the Norwegian Institute, and he succeeded the veteran Prof. Möhn in the directorship in September, 1913. He contributed many papers to meteorological literature on the climate and weather of Norway, but he is perhaps best known for his comprehensive report on the observations made at the Norwegian station at Bossekop in connection with the international exploration of the polar regions during the years 1882–83, and for his report on the terrestrial magnetic results of the second Norwegian Arctic Expedition in the *Fram* in 1898–1902. The latter report was supplemented by an interesting discussion on the diurnal variation of terrestrial magnetism in the northern hemisphere. Dr. Steen's visit to England in 1904 as a member of the International Solar Commission which met at Cambridge in that year, is pleasantly remembered by those who met him on that occasion. He was born at Christiania in 1849, and died there on May 10.

IN this country it is unfortunately so rare to find young men, equipped by a scientific training with the exact habit of mind essential to all historical studies, willing to turn their attention to art-history and museum-management, that the loss of such a promising recruit as Second-Lieutenant Percy Herman Charles Allen (3rd attached to 2nd Battalion East Lancashire Regiment), killed in action in France on May 9, is much to be deplored. Educated as a mathematical exhibitioner of Christ's Hospital, and scholar of Caius College, Cambridge, Mr. Allen became for a time an assistant in the Victoria and Albert Museum, and in January, 1914, was appointed assistant keeper in the fine art department of the Ashmolean Museum, Oxford. His natural taste and exactitude of perception were beginning to find true scope in the complicated task of determining questions of states and copies amongst the early engravings forming part of the vast collections bequeathed by Francis Douce to the University. In a short time he did much valuable work. A remarkable memory and grasp of the nature of facts gave his judgment the sureness only acquired as a rule by long experience. It seemed safe to predict that his career, cut short at twenty-five years, showed promise of a future of much brilliance.

THE late Captain S. A. Macmillan, attached to the 58th (Vaughan's) Rifles, Indian Army, whose death at the front has recently been reported, had been engaged for about a year on the work of the survey of the mammalian fauna of India, Burma, and Ceylon. This survey was started in 1911 by the Bombay Natural History Society with the object of carrying out, in conjunction with the British Museum (Natural History), a systematic study of the Indian mammal fauna. Early last year the society secured the services of Capt. Macmillan as a collector in Burma to work with another of their collectors, Mr. Guy Shortridge, who is now serving in France as an officer of the 29th Bengal Lancers. Capt. Macmillan had been on a rubber estate in Tenasserim, and was not only a keen hunter, but also possessed a local knowledge of languages, etc., which proved of great value to both collectors whilst in Burma. They were doing splendid work for the survey, and had made a very fine collection of mammals from Monywa and Kindat in Upper Chindwin and elsewhere in Burma when the war broke out, and abruptly put a stop to their efforts in this direction, the activities of both being transferred to the military. Before leaving India Mr. Shortridge and Capt. Macmillan exhibited their specimens at a meeting of the Bombay Natural History Society, the fine series of different squirrels particularly creating much interest. The Society has lost in Capt. Macmillan a keen worker of the highest efficiency, who promised to accomplish still more valuable work towards bringing the survey to a completion.

BY the recent death of Prof. D. A. Louis, at fifty-eight years of age, the technical Press has lost one of its most gifted representatives. A Londoner by birth, he studied at the Royal School of Mines in the year 1876 and 1881, devoting most of his attention to chemistry, metallurgy, and physics. From 1882 to 1886 he was employed at Rothamsted on agricultural research, and there carried out important experiments for Sir John Lawes. His connection with mining and metallurgy is to be traced to an appointment he had in Colorado, where he gained practical experience in mining. From 1891 he practised as a consulting mining engineer and metallurgist in London, making periodical visits abroad to most of the European and American mining districts. In 1893 he became an assistant examiner in mining to the Board of Education, and in 1900 was appointed professor of mining at the Yorkshire College at Leeds. In 1907 he took a prominent part in the third International Petroleum Congress at Bucharest. In 1910 he was hon. secretary of the metallurgical section of the seventh International Congress of Applied Chemistry; and as a

petroleum mining expert he visited Egypt, Russia, Galicia, and Rumania. As a journalist Prof. Louis had a marvellous gift of assimilating information rapidly; and his wide scientific knowledge was never at a loss. He was a constant contributor to many leading technical journals in this country, and frequently reported meetings of the British Association for the *Times*, the *Engineer*, etc. Prof. Louis was for many years foreign representative of the International Association of Journalists. He acted as hon. secretary for the congress which was held in this country in the year 1909, when his gifts as a linguist, his knowledge of foreign countries, and his geniality and *savoir faire* were invaluable. His loss is deeply felt by a large number of friends.

IN an article entitled "Stricken Serbia" in the *Times* of May 28, a distressing picture is given of the ravages of typhoid, typhus, and relapsing fever in that country. The two last diseases, which accounted for some 15,000 of the sufferers, were traced to the Austrians who left their sick at Valievo. The conditions on the arrival of the various relief organisations were appalling; an observer speaks of "the mass of fever patients lying in all their filthy and verminous rags on the floors and under the beds of what are not hospitals but mere charnel-houses for the dying"! Nevertheless, in less than two months the diseases were got under, typhus being almost stamped out. This was accomplished by the energy of Colonel Hunter and Lieut.-Colonel Stammers and the devoted band of doctors and nurses acting under their direction. Six months of war had depleted the country of stores and provisions, and hospital stores and comforts had to be brought from England or Malta. Clearly the first need was to break the lines of communication between the troops and the rest of the country. Quarantine stations were established, all railway communication was suspended for fifteen days, all leave from the army was stopped, and soldiers on leave were recalled. The problem of typhus was comparatively simple, as this disease is spread by lice. Three weeks were given up to the disinfection of clothes, blankets, and linen; and hospitals and their contents were disinfected. Notification was enforced, and infectious patients were removed to isolation hospitals. The sanitary staff travelled from place to place in a special train and instructed the people what to do. Preventive inoculation especially against cholera was also resorted to, as this dread disease is very likely to break out under such conditions. The work was carried out by two hospital units, Lady Paget's and Lady Wimborne's, each with about fifty doctors, nurses, and orderlies, and by smaller contingents under Dr. Moon and Mrs. Hardy.

MR. G. F. CHAMBERS, whose death on May 24 at seventy-four years of age we regret to record, was a very voluminous writer on many subjects, legal, political, ecclesiastical, but the book which gives him the best scientific claim to remembrance was written when he was not yet twenty years of age. This was the "Handbook of Descriptive Astronomy." In 1861, though England then boasted a distinguished and zealous band of amateur astronomers, amongst whom were numbered men like Birt, Dawes, De la Rue, Green, and Webb, there was no literature to meet their special necessities. The first edition of Mr. Chambers's "Handbook," published in December, 1861, formed an admirable compendium of the results of astronomical science at that date in the departments which particularly appealed to the amateur observer. The success of the adventure was pronounced; other editions followed, and when the fourth and last edition was brought out, in 1889 and 1890, the book had expanded into three volumes, containing altogether more than 1600 pages. The speciality of the work lies in the number which it contains of useful catalogues, of auxiliary tables for the simple reductions of a private observatory, of descriptions of different forms of telescope mountings and houses adapted for small observatories, and so forth. Mr. Chambers, though he was himself the possessor of one of the small observatories for which he especially catered, did not contribute much to science by his own personal observations, but he was indefatigable in compiling useful or popular works on the subject. One work upon which he bestowed a great amount of labour, viz. his revision of Admiral Smyth's "Celestial Cycle," proved a failure, since his direct practical knowledge of double star astronomy was not sufficient to warrant him in undertaking so important a task; but his smaller and more popular astronomical books have met a cordial reception from the public. These are his "Pictorial Astronomy" and his "Stories" of the sun, stars, eclipses, weather, and comets. He was an original member of the British Astronomical Association, and served for many years as vice-president or on its council. In connection with this association, he took a great interest in eclipse expeditions, and spared no time or energy in ascertaining the best routes by which intending observers could travel to places within the shadow track.

THE *Daily Telegraph* published a telegram "From our own correspondent at Copenhagen," on May 26, reporting that "A Danish surgeon and scientist of the highest reputation has succeeded in discovering what the German soldiers use to protect themselves against the asphyxiating gases which they employ against the enemy." The "discovery" is that the Germans make use of solutions of hyposulphite and bicarbonate of soda to moisten their respirators. The announcement reminds us, however, of the belated discovery of the lamented death of Queen Anne! The use of such solutions is well known to all workers with chlorine gas, and was mentioned in daily papers a day or two after the Germans commenced to discharge the gas upon our troops.

DR. A. R. FRIEL describes, under the term "pianticated," modifications of microbes induced by treating them one or more times with blood-serum, which are transmissible to, and cumulative in, their descendants. Thus organisms which previously almost completely resisted ingestion by leucocytes when "pianticated" are ingested in large numbers by leucocytes (South African Institute for Medical Research, January 26, 1915).

IN the Proceedings of the National Academy of Sciences, Washington (vol. i., p. 256), Dr. C. D. Walcott announces the discovery of bacteria in one of the petrified algæ from pre-Cambrian rocks in Montana, to which reference was made in NATURE last week (p. 354). They appear in the algal tissue as irregular chains of darkly stained cells from 0·95 to 1·3 microns in diameter, and are very suggestive of Micrococcus. It is not always possible to distinguish with certainty such fossils from purely mineral structures, but satisfactory traces of bacteria have already been detected in the fossilised remains both of animal and plant tissues in European Palæozoic rocks, and they are to be expected among the earliest organisms.

THROUGH Mr. Bassett Digby, the geological department of the British Museum (Natural History) has lately obtained a well-preserved front horn of the woolly rhinoceros from the frozen earth of northern Siberia. The specimen measures nearly a metre in length, and, though partly cut as usual by the natives who found it, shows the backward curvature of its slender apex and the lateral compression of its characteristic sharp posterior border. The new horn has been mounted, with a hinder horn already in the museum, above one of the exhibited skulls of woolly rhinoceros from Siberia. It is thus possible to realise the unusually large proportions of the horns in this extinct species.

THE question of the pollution of the air of our manufacturing towns has been a serious one for some time, and the report of the Air Pollution Advisory Board of the city of Manchester will prove a valuable document to those seeking to mitigate a serious evil. It appears that the domestic grate is the principal offender and that the modern factory with mechanical stokers is comparatively, if not absolutely, innocent. In many cases, however, the impurities are not due to indifferent stoking, and for these the electrostatic method of precipitation which has proved so successful in America may be recommended. An interesting account of the method and the results of its application will be found in the *Electrical Review* for May 14. Briefly, the polluted air passes between electrodes maintained at a difference of potential of 100,000 volts, and the particles of carbon, arsenic, potash, or chlorine are carried by the discharge to one of the electrodes. About five kilowatts are necessary to deal with about 30,000 cu. ft. of air per minute, so that the cost is slight. In many of the cases cited the value of the material recovered in a year exceeded the cost of installation and working of the apparatus.

THE *Times* Engineering Supplement for May 28 touches on a point in works organisation to which too little attention has been given in this country, especially in the case of small- and medium-sized factories. Before the war, our industries suffered severely from German competition; this has been attributed in varying degrees to free trade, lack of technical education, and so forth. As the output of our factories must now be increased, our contemporary asks: Given perfect workmen and entire absence of alcohol, is the management of such a high order that the output is a maximum? Are the proprietors, or directors, so wholehearted in their patriotism that they lose no time? Are they so skilled in their respective spheres that they are able to guide their staff and workmen? In large firms the organisation is generally of a high order of efficiency, but it must be confessed that a large number of small firms work from hand-to-mouth in such a manner that output and delivery of orders to a stated time are quite problematic matters. Many of these smaller concerns are in the hands of a family, or financial men, who know nothing of the work being carried on, and whose sole object is to derive as large an income as possible with the minimum of effort. Such firms which are not producing a good average should be visited by skilled managers, and the real cause located. If lack of capital is the cause, the Government should assist; if incompetent management, the offenders should be removed; and if the cause is lack of plant which cannot be immediately rectified, the factory should be closed and the men drafted to a well-organised concern.

THE director of the Geological Survey of the Union of South Africa asks us to announce that no annual report of the Survey will be issued for the year 1914. The announcement is made to spare the necessity of inquiries from the many scientific institutions, etc., which are on the complimentary list of the Survey.

ERRATUM.—In equation 2 on p. 359 of NATURE of May 27, the symbol T should appear as a factor in the denominator of the fraction, and there should be a minus sign before r in the numerator. Both omissions were overlooked by the author in two proofs corrected by him.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF NEBULÆ AT THE HELWAN OBSERVATORY.—Mr. H. Knox Shaw describes in Bulletin No. 15 of the Helwan Observatory the observations made with the Reynolds reflector up to the end of September of last year, this paper being a continuation of that published in Bulletin No. 9. This work is described as being somewhat of a reconnaissance to see which nebulæ would repay photographing with long exposures when the new Ritchey 30-in. mirror is mounted. The paper gives a list of the nebulæ observed, and also one of thirty-one new nebulæ confirmations of which have been made by second photographs in each case. Referring to N.G.C. 6729, the nebulæ attached to the variable star R. Coronæ, Aust., the author states that this nebula is certainly variable, and the question as to how its variability is connected with that of the star is being studied, and is promised as a separate paper.

STARS WITH PROPER MOTION EXCEEDING 0·50″ ANNUALLY.—Mr. Adriaan van Maanen contributes to the April number of the *Astrophysical Journal* (vol. xli., No. 3) a very useful list of stars with proper motion exceeding 0·50″ annually. This list is based on Porter's and Kobold's lists, which indicated proper motions greater than 0·50″ annually, on Bossert's catalogue of proper motions of 2641 stars, and on numerous other subsequently published notes on stars of large proper motion. The present list is made as far as possible homogeneous throughout, and deals with 533 stars. A column is given showing the spectra of the stars as determined by Mr. W. S. Adams or Miss Cannon. The positions in right ascension and declination are

for the equinox 1900·0, and the proper motions are given for both amount and direction. Remarks regarding uncertainties in proper motions are added, and in the case of double stars, the number in Burnham's General Catalogue is given. Attention is directed to a list by Innes of proper-motion stars south of $-19°$; this appeared subsequent to the printing of the present paper, and Mr. van Maanen adds the numbers of Innes's list which should be included in his communication.

ORBITS OF VARIABLE RADIAL VELOCITY STARS.—In the April number of the Journal of the Royal Astronomical Society of Canada some reductions are given of the measures of the variable radial velocities of stars. The orbit of 136 Tauri, deduced by J. B. Cannon, is based on sixty plates taken at the Ottawa Dominion Observatory between November, 1911, and January, 1915. The paper gives a list of the observations. The spectrum of this star is of the A type, and the deduced period is 5·969 days. The same writer deals also with the orbit of ξ Andromedæ, a star of the K type spectrum, and utilises fifty-eight plates taken at the same observatory between September, 1913, and February, 1915. On the average about twelve lines were measured on each plate, and, generally speaking, the agreement was very fair. The final period derived was 17·767 days. In both of the above stars comparisons are made with the Lick Observatory results. The orbits of the spectroscopic components of 50 Draconis are discussed by W. E. Harper from the velocities of the ten plates secured at the Yerkes Observatory, and thirty-four taken at the Dominion Observatory. Both spectra were of the A type. The Yerkes and Ottawa observations both indicate a period of 4·120 days. The determination of the orbit of the spectroscopic binary, 1149 Groombridge, was also undertaken by the same writer using thirty spectrograms secured at Ottawa and three secured by Adams. The star is of the A5 type, and the spectrum has numerous lines well adapted for measurement. In the list of final elements derived the period is given as 9·944 days.

MANCHESTER ASTRONOMICAL SOCIETY.—No. 1 of the Journal of the Manchester Astronomical Society, for the session 1913–14, gives a brief account of the origin of the society and a statement as to its growth since its foundation in 1903. The object is for the association of amateur astronomers, for mutual help, their organisation in the work of astronomical observation, and the encouragement of a popular interest in astronomy. The society numbers at present 131 members, and its president is the Rev. A. L. Cortie, S.J. The journal gives excellent portraits of the present and past four presidents; and the address of the president on the origin of the sun and stars is printed and illustrated with three plates. A paper on Japanese and other magic mirrors is from the pen of the late Mr. T. Thorp, who was an original and active member of the society. Lunar photography, by Mr. William Porthouse; astronomy and æsthetics, by Mr. E. Denton Sherlock; and a remarkable solar prominence, by Mr. A. Buss, form the subjects of other papers printed in this issue.

CONSTITUENTS OF EXTRACTS DERIVED FROM ALBUMINOUS SUBSTANCES.

A JOINT meeting of the Society of Public Analysts and the Biochemical Society, which was held at the Chemical Society's Rooms on May 5, was devoted to the discussion of the methods adopted in estimating the nitrogenous constituents of extracts derived from albuminous substances, such as meat extracts. Mr. A. Chaston Chapman, the chairman, in opening the discussion, pointed out that from the technical point of view the purposes to be served by such analyses were, first, to indicate the general character of the process by which any particular extract had been prepared; secondly, to throw some light on the source of the extract and its genuineness or otherwise; and, finally, to furnish information as to the physiological properties of dietetic value. He then gave an outline of the existing methods of analysis, and emphasised their limitations; more particularly the practice of returning the "residual nitrogen" as "meat bases," using the factor 3·12 for the conversion was a source of uncertainty and confusion, especially as Hehner had suggested the use of the ordinary protein factor, 6·25, for the same purpose. The best plan was to return the actual nitrogen percentages.

Dr. F. Gowland Hopkins, dealing with the question of the food value of meat extracts and similar preparations, pointed out that the animal body dealt not with the intact proteins, or even with the albumoses and peptones, but with the free amino-acids which were the individual constituents of the protein molecules. The way in which these acids were grouped in the protein molecule was not of much consequence, but the effects produced by the individual amino-acids were of extreme importance. He described physiological experiments which he had made showing that when rats were given a diet including a complete amino-acid mixture corresponding with the proteins of an ordinary diet, the growth was almost exactly normal, but when arginine and histidine were removed from the mixture, growth ceased immediately, but was again resumed when the missing constituents were added. The removal of tryptophane produced similar results, and Osborne and Mendel had, in America, shown that cystine was similarly essential. It did not follow that this was the case with every amino-acid, and the question as to which of these were vitally necessary offered a large field for investigation. Experiment had shown that in the case of rats, the critical minimum for arginine lay somewhere between 2½ and 1 per cent. The functions of the individual amino-acids were not confined merely to flesh formation. Thus, for example, the effect of feeding animals on zein, which was deficient in both tryptophane and lysine, was not only to restrict growth, but to shorten the survival; the same was true with zein *plus* lysine, but with zein *plus* tryptophane the animal was able to maintain its weight for a long period, although it did not grow.

Dr. E. P. Cathcart said that observations at present available were so scanty that it could not be said with certainty that creatine and creatinine had a special niche in the organism. He did not think that any end would be gained by the separate estimation of these two substances. Mr. A. R. Tankard and Mr. E. Hinks dealt with questions of procedure, and Dr. Percival Hartley described his experience of Van Slyke's method of estimating amino-nitrogen; further remarks were made by Dr. Rideal, Prof. Barger, Dr. Harden, and Dr. S. Walpole.

MUSEUMS AND EDUCATION.

THE *Museums Journal* for May contains an interesting and suggestive article on the educational work of American museums, by the director of the Charleston Museum. It is abundantly clear from this that the functions of the museum in America are, so to speak, intensively cultivated. And nowhere is this more apparent than in the facts which he gives in regard to the co-operation which has grown up between the museums and the public schools. It is now the rule, he tells us, for children to be brought

in batches by their teachers for regular instruction by the museum staff. This is given partly in the form of tours round the galleries, and partly by lectures given in class-rooms set apart for this purpose. Instruction is also provided for higher-grade scholars and for the teachers themselves.

In some places, as in Philadelphia, to obviate loss of time in taking large classes to the museum, it is now customary to send travelling exhibits from the museum to the schools.

Further efforts to utilise the museum as a means of education have resulted in the formation of children's museums, where collections of birds and beasts likely to interest children are arranged so as to convey some definite and easily assimilated ideas, as, for example, on the significance of animal coloration, or the shapes of animals.

The rapid increase of vocational and industrial training in the public schools of America, the author remarks, is already creating a demand for further assistance from museums, which they are meeting by lectures on the relation of natural resources to commerce and industry, and by exhibits illustrating processes of manufacture. It is probable that this is but the beginning of a phase of museum work which will ultimately occupy a large place in the activities of general museums and lead to the establishment of special industrial museums.

This appreciation of the functions of museums is a healthy sign, and might well be emulated in this country, where the museum is still commonly looked upon as a kind of "curiosity shop." Isolated attempts have been made on the part of many of our local museums to induce the public to make greater use of the collections exhibited for their benefit, but the Board of Education has yet to be educated in regard to the possibilities of museums. At the British Museum much valuable work is being done in the direction of economic zoology, but the scope of this work is hampered by lack of adequate financial support.

This very suggestive essay should be widely read in this country, for there can be no doubt that the educational advantages offered by our museums are little known or utilised by educational authorities.

MEASUREMENT OF THE DISTANCES OF THE STARS.[1]

FOR the lecture in honour and memory of Edward Halley, which it is my privilege to deliver this year, I have chosen an account of the persistent efforts made by astronomers to measure the distances of the fixed stars. For many generations their attempts were unsuccessful, though some of them led to great and unexpected discoveries. It is less than eighty years ago that the distances of two or three of the nearest stars were determined with any certainty. The number was added to, slowly at first, but afterwards at a greater rate, and now that large telescopes are available and photographic methods have been developed, we may expect that in the next few years very rapid progress will be made.

For many centuries astronomers had speculated on the distances of the stars. The Greeks measured the distance of the moon; they knew that the sun and planets were much further away, and placed them correctly in order of distance, guessing that the sun was nearer than Jupiter because it went round the sky in one year while Jupiter took twelve. The stars, from their absolute constancy of relative position, were rightly judged to be still more distant—but how much more they had no means of telling.

In 1543 Copernicus published "De Revolutionibus Orbium Cœlestium," and showed that the remarkable movements of the planets among the stars were much easier to understand on the hypothesis that the earth moved annually round the sun. Galileo's telescope added such cogent arguments that the Copernican system was firmly established. Among other difficulties which were not cleared up at the time one of the most important was this: If the earth describes a great orbit round the sun, its position changes very greatly. The question was rightly asked: Why do not the nearer stars change their positions relatively to the more distant ones? There was only one answer. Because they are so extremely distant. This was a hard saying, and the only reply which Kepler, who was a convinced believer in the earth's movement round the sun, could make to critics was "Bolus erat devorandus."

Although no differences in the positions of the stars were discernible to the naked eye, it might be that smaller differences existed which could be detected by refined astronomical measurements. To the naked eye a change in the angle between neighbouring stars not more than the apparent diameter of the sun or moon should be observable. No such changes are perceived. The stars are—it may be concluded—at least two hundred times as distant as the sun. With the instruments in use in the seventeenth century—before the telescope was used for the accurate measurement of angles—angles one-twentieth as large were measurable, and the conclusion was reached that the stars were at least four thousand times as distant as the sun. But no positive results were obtained. Attempts followed with the telescope and were equally unsuccessful. Hooke tried to find changes in the position of the star γ Draconis and failed, Flamsteed, Picard, and Cassini made extensive observations to detect changes in the position of the pole star and failed. Horrebow thought he had detected slight changes in the position of Sirius due to its nearness in a series of observations made by Römer. He published a pamphlet, entitled "Copernicus triumphans," in 1727, but the changes in the position of Sirius were not verified by other observers, and were due to slight movements of Römer's instruments.

Thus in Halley's time it was fairly well established that the stars were at least 20,000 or 30,000 times as distant as the sun. Halley did not succeed in finding their range, but he made an important discovery which showed that three of the stars were at sensible distances. In 1718 he contributed to the Royal Society a paper entitled "Considerations on the Change of the Latitude of Some of the Principal Bright Stars." While pursuing researches on another subject, he found that the three bright stars—Aldebaran, Sirius, and Arcturus—occupied positions among the other stars differing considerably from those assigned to them in the Almagest of Ptolemy. He showed that the possibility of an error in the transcription of the manuscript could be safely excluded, and that the southward movement of these stars to the extent of 37′, 42′, and 33′—*i.e.* angles larger than the apparent diameter of the sun in the sky—were established. He remarks:—

"What shall we say then? It is scarce possible that the antients could be deceived in so plain a matter, three observers confirming each other. Again these stars being the most conspicuous in heaven are in all probability nearest to the earth, and if they have any particular motion of their own, it is most likely to be perceived in them, which in so long a time as 1800 years may show itself by an alteration of their places, though it be utterly imperceptible in a single century of years."

This is the first good evidence, *i.e.* evidence which

[1] The "Halley Lecture" (slightly abridged), delivered at Oxford on May 20, by Sir F. W. Dyson, F.R.S., Astronomer Royal.

we now know to be true, that the so-called fixed stars are not fixed relatively to one another. It is the first positive proof that the distances of the stars are sensibly less than infinite. This, then, is the stage at which astronomers had arrived less than two hundred years ago. The stars are at least 20,000 or 30,000 times as distant as the sun, but three of the brightest of them are perceived to be not infinitely distant.

The greatest step in the determination of stellar distances was made by another Oxford astronomer, James Bradley. His unparalleled skill as an astronomer was early recognised by Halley, who tells how "Dr. Pound and his nephew, Mr. Bradley, did, myself being present, in the last opposition of the sun and Mars this way demonstrate the extreme minuteness of the sun's parallax, and that it was not more than 12 seconds nor less than 9 seconds." Translated from astronomical language, the distance of the sun is between 95 and 125 millions of miles. Actually the distance is 93 million miles. The astronomer who so readily measured the distance of the sun entered on the great research which had baffled his predecessors—the distance of the stars.

The theory of the determination of stellar parallax is very simple: the whole difficulty lies in its execution, because the angles are so small that the slightest errors vitiate the results completely. Even at the present time with large telescopes, and mechanism which moves the telescope so that the diurnal movement of the stars is followed and they appear fixed to the observer in the field of the telescope, and with the additional help of photography, the determination of the parallax of a star requires a good deal of care, and is a matter of great delicacy. But in Bradley's time telescopes were imperfect, and the mechanism for moving them uniformly to follow the diurnal rotation of the stars had not been devised.

This was in some ways very fortunate, as the method Bradley was forced to adopt led to two most important and unexpected discoveries. Every day, owing to the earth's rotation, the stars appear to describe circles in the sky. They reach the highest point when they cross the meridian or vertical plane running north and south. If we leave out all disturbing causes and suppose the earth's axis is quite fixed in direction, a star S, if at a great distance from the earth, will always cross the meridian at the same point S; but, if it is very near, its movement in the small parallactic ellipse will at one period of the year bring it rather north of its mean position and at the opposite period an equal amount south.

Bradley, therefore, designed an instrument for measuring the angular distance from the zenith, at which a certain star, γ Draconis, crossed the meridian. This instrument is called a zenith sector, and is shown in the slide. The direction of the vertical is given by a plumb-line, and he measured from day to day the angular distance of the star from the direction of the vertical. From December, 1725, to March, 1726, the star gradually moved further south; then it remained stationary for a little time; then moved northwards until, by the middle of June, it was in the same position as in December. It continued to move northwards until the beginning of September, then turned again and reached its old position in December. The movement was very regular and evidently not due to any errors in Bradley's observations. But it was most unexpected. The effect of parallax—which Bradley was looking for—would have brought the star furthest south in December, not in March. The times were all three months wrong. Bradley examined other stars, thinking first that this might be due to a movement of the earth's pole. But this would not explain the phenomena. The true explanation, it is said, although I do not know how truly, occurred to Bradley when he was sailing on the Thames, and noticed that the direction of the wind, as indicated by a vane on the mast-head, varied slightly with the course on which the boat was sailing. An account of the observations in the form of a letter from Bradley to Halley is published in the *Philosophical Transactions* for December, 1728:—

"When the Year was compleated, I began to examine and compare my Observations, and having pretty well satisfied myself as to the general Laws of the *Phenomena*, I then endeavoured to find out the Cause of them. I was already convinced that the apparent Motion of the Stars was not owing to a Nutation of the Earth's Axis. The next thing that offered itself, was an Alteration in the Direction of the Plumb-line, with which the instrument was constantly rectified; but this upon trial proved insufficient. Then I considered what Refraction might do, but here also nothing satisfactory occurred. At last I conjectured that all the *Phenomena* hitherto mentioned, proceeded from the progressive Motion of Light and the Earth's Annual Motion in its Orbit. For I perceived that, if Light was propagated in Time, the apparent Place of a fixed Object would not be the same when the Eye is at Rest, as when it is moving in any other Direction, than that of the Line passing through the Eye and the Object; and that, when the Eye is moving in different Directions, the apparent Place of the Object would be different."

This wonderful discovery of the Aberration of Light is usually elucidated by the very homely illustration of how an umbrella is held in a shower of rain. Suppose the rain were falling straight down and a man walking round a circular track: he always holds the umbrella a little in front of him—because when he is walking northward the rain appears to come a little from the north, when he is going eastward it appears to come a little from the east, and so on.

Although the phenomena Bradley had observed were almost wholly explained in this way, there were still some residual changes, which took nineteen years to unravel; and he explained these by a nutation or small oscillation of the earth's axis, which took nineteen years to complete its period. I cannot dwell on these two great discoveries. For our present purpose, it should be said that aberration and nutation cause far greater changes in the apparent positions of the stars than, we now know, are caused by parallax. Until they were understood and allowed for or eliminated, all search for parallax must have been in vain. Further, Bradley's observations showed that in the case of γ Draconis, at any rate, parallax did not displace the star by so much as 1·0″ from its mean position, or that the star was 200,000 times as distant as the sun. We may say that Bradley reached to just about the inside limit of the distances of the nearer stars.

Let me now try to give some idea of what is meant by a parallax of 1″, which corresponds to a distance 200,000 times that of the sun. Probably many of you have looked at the second star in the tail of the Great Bear, Mizar, it is named, and have seen there is a fainter star near it, which you can see nicely on a fine night. These stars are 600″ apart; with a big telescope with a magnification of 600 times—and this is about as high a magnification as can be generally used in England—two stars 1″ apart are seen double just as clearly as Alcor and Mizar are seen with the naked eye. I think this is the most useful way to think of 1″—a very small angle, which one needs a magnification of 600 times to see easily and clearly. Bradley showed that γ Draconis did not wander by this amount from its mean position among the stars in consequence of our changing view-point.

The next attempt to which I wish to refer is the

one made by Sir William Herschel. In a paper communicated by him to the Royal Society in December, 1781, he reviews the serious difficulties involved in determining the parallax of a star by comparing its zenith distance at different times of the year. Especially there is the uncertainty introduced by the refraction of light, and in addition as the angular distances of stars from the zenith are changed by precession, nutation, and aberration, any errors in the calculated amount of these changes will all affect the results. He proposed, therefore, to examine with his big telescope the bright stars and see which of them had faint stars near them. The bright stars, he said, are probably much nearer than the faint stars; and if the parallax does not even amount to 1″ the case is by no means desperate. With a large telescope of very great perfection it should be possible to detect changes in the angular distance of two neighbouring stars. By this differential method the difficulties inherent in the method of zenith distances will be eliminated. Herschel made a great survey to find suitable stars, and in this way was led to the discovery of double stars—*i.e.* of pairs of stars which are physically connected and revolve around one another, just like sun and earth. This was a most important discovery, but as the two components of a double star are practically at the same distance from us they do not serve to determine parallax, for which we need one star to serve as a distant mark.

For another forty years persistent efforts were made without success. Piazzi, in Italy, thought he had detected parallax in Sirius and a number of other bright stars, but the changes he detected in the zenith distances were unquestionably due to errors introduced by uncertainty in refraction, or slight changes in the position of his instruments in the course of the year. Dr. Brinkley, in Dublin, made a gallant effort and took the greatest pains. He thought he had succeeded, and for many years there was a controversy between him and Pond as to whether his results were trustworthy. The state of knowledge of the distances of the fixed stars in 1823 is summed up accurately by Pond in the *Philosophical Transactions*:—

"The History of annual parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the Continent; and accordingly it shows a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established, beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion than that this is the reason why it discovers no parallax at all."

Besides these and other efforts to find parallax in the zenith distances of stars, attempts were also made to detect changes in the time at which the stars cross the meridian, to see if they are slightly before their time at one period of the year and slightly after it at another. But these, too, were unsuccessful, even in the hands of astronomers like Bessel and Struve. The best were some observations of circumpolar stars made by Struve in Dorpat between 1814 and 1821. The following table shows some of the results at which he arrived:—

Polaris and ϵ Urs. Maj. ...	$\pi + 0{\cdot}053\pi' = +0''{\cdot}075 \pm 0''{\cdot}034$
ϵ Urs. Maj. and α Cass....	$\pi + 0{\cdot}962\pi' = -0{\cdot}136 \pm 0{\cdot}110$
ζ Urs. Maj. and δ Cass. ...	$\pi + 1{\cdot}099\pi' = +0{\cdot}175 \pm 0{\cdot}127$
β Urs. Min. and α Persei	$\pi + 0{\cdot}402\pi' = +0{\cdot}305 \pm 0{\cdot}071$
Capella and β Drac. ...	$\pi + 1{\cdot}147\pi' = +0{\cdot}134 \pm 0{\cdot}139$
β Aurig. and γ Drac. ...	$\pi + 1{\cdot}138\pi' = +0{\cdot}020 \pm 0{\cdot}117$

This table has the merit of not looking wildly impossible in the present state of our knowledge. It has the disadvantage of not giving a definite parallax to each star. For example, it is impossible to say how much of the 0·134″ is to be given to Capella and how much to β Draconis. Further, the probable errors, though really small, are nearly as large as the quantities determined.

Struve and Bessel therefore attempted the problem by the differential method recommended by Herschel. By this time it had become easier to carry out. The method of mounting telescopes equatorially had been devised, so that the telescope was always kept pointing to the same part of the sky by clockwork-driven mechanism. Struve chose the bright star α Lyræ, and measured its distance from a faint star about 40″ away on ninety-six nights between November, 1835, and August, 1838. In the focal plane of his telescope he had what is called a position micrometer. The micrometer contains two parallel spider-threads stretched on frames, and the frames are movable by screws until the position shown in the diagram is reached: the distance apart of the threads is known by the readings of the screw-heads. He found that α Lyræ had a parallax 0·262″ with a probable error ±0·025″.

Bessel chose the star 61 Cygni as a likely star to be near the sun, and therefore to have appreciable parallax. 61 Cygni is not nearly so bright as α Lyræ, but has a very great angular movement or proper-motion among the stars. Bessel used an instrument called a heliometer. Like Struve's telescope, it was mounted so that it could be driven by clockwork to point always at the same star. The object-glass of Bessel's telescope was made by the great optician Fraunhofer, with the intention of cutting it in halves. Fraunhofer died before the time came to carry out this delicate operation, but it was successfully accomplished after his death.

Delicate mechanism was provided for turning the glass, and also for moving the two halves, the amount of movement being very accurately measured by screws. Each half gives a perfect image of any object which is examined, but the two images are shifted by an amount equal to the distance one-half of the lens is moved along the other. Thus when a bright star and faint star are looked at, one-half of the object-glass can be made to give images S and *s*, and the other half S′ and *s*′. By moving the screw exactly the right amount *s*′ can be made to coincide with S, and the reading of the screw gives a measure of the angular distance between the two stars. Bessel made observations on ninety-eight nights extending from August, 1837, to September, 1838. The table, taken from a report by Main (Mem. R.A.S., vol. xii., p. 29), shows how closely the mean of the observations for each month accords with the supposition that the star has the parallax 0·369″:—

Mean date	Observed displacement	Effect of parallax 0″·369
	1837.	
	″	″
August 23 ...	+0·197 ...	+0·212
September 14 ...	+0·100 ...	+0·100
October 12 ...	+0·040 ...	−0·057
November 22 ...	−0·214 ...	−0·258
December 21 ...	−0·322 ...	−0·317
	1838.	
January 14 ...	−0·376 ...	−0·318
February 5 ...	−0·223 ...	−0·266
May 14	+0·245 ...	+0·238
June 19 ...	+0·360 ...	+0·332
July 13	+0·216 ...	+0·332
August 19 ...	+0·151 ...	+0·227
September 19 ...	+0·040 ...	+0·073

Simultaneously with these determinations of the distance of α Lyræ and 61 Cygni, the distance of α Centauri, one of the brightest of the southern stars, was found by Henderson from observations of zenith distance made by him at the Cape between April, 1832, and May, 1833. He learnt just before the termination of his residence at the Cape that this star had a very large proper-motion. Suspecting a possible parallax, he examined the observations when he had taken up his new office of Astronomer Royal for Scotland, and found a parallax amounting to 0·92″. He did not, however, publish his results until he found that they were confirmed by the right ascensions. In a communication to the Royal Astronomical Society in December, 1838, he states that it is probable that the star has a parallax of 1·0″.

The great and difficult problem which had occupied astronomers for many generations was thus solved for three separate stars in 1838:—

	Parallax	Distance	Modern observations	
			Parallax	Distance
	″		″	
α Centauri (Henderson)	1·0	200,000	0·750	270,000
61 Cygni (Bessel)	0·314	640,000	0·285	700,000
α Lyræ (Struve)...	0·262	760,000	0·10	2,000,000

(The unit of distance is that from the earth to the sun.)

Henderson's observation is interesting because α Centauri is, as far as we yet know, the nearest of all the stars to us. But by far the most valuable of these observations is Bessel's. The heliometer, which he devised, proved itself to be by far the most serviceable instrument for determining stellar parallax until the application of photography for this purpose.

The somewhat dramatic manner in which the distances of three stars were determined in the same year, after several centuries of failures, may have led to the hope that the range of many more stars would soon be found. This was not the case, however. Each star had to be measured separately, and involved many nights of observations. The quantities to be measured were so small that they taxed the resources of the best instruments and best observers. In 1843 Peters published the parallaxes of half a dozen stars determined with the vertical circle at Pulkova, but the parallax of only one of these, Polaris, is obtained with much accuracy. With Bessel's heliometer, Schlüter and Wichmann measured the distance of Gr. 1830, the star which had the largest known proper-motion. In the 'sixties, Auwers with the same instrument determined the parallax of several quick-moving stars, and also of the bright start Procyon. With the Bonn heliometer, Krueger in the 'sixties measured the distance of three stars, and Winnecke two more. Other observations were made, amongst others, by Maclear, Otto Struve, Brünnow, and Ball; but as these observers had not such suitable instruments, their results were not of the same high standard of value. A generous estimate would place the number of stars the distances of which had been satisfactorily determined before 1880 at not more than twenty.

In the 'eighties, progress became more rapid. Gill, the Astronomer Royal for the Cape, in conjunction with a young American astronomer, Elkin, determined with great accuracy, though with only a small 4-in. heliometer, the distance of nine stars of the southern hemisphere. These stars included α Centauri, and the bright stars Sirius and Canopus. These results were communicated to the Royal Astronomical Society in 1884. The work of Gill and Elkin did not stop there. After some years, a very fine 7-in. heliometer was obtained at the Cape, and with it, between 1888 and 1898, the parallaxes of seventeen stars were determined by Gill and his assistants with very great accuracy. The stars observed at the Cape consisted of the brightest stars of the southern hemisphere, and of the stars with the greatest proper-motions. The results were remarkable. The stars with large proper-motions were nearly always comparatively near—say within one million times the sun's distance. On the other hand, some of the very brightest stars, particularly Canopus, the brightest star in the sky after Sirius, were at vastly greater distances.

Meanwhile, Elkin, who had been appointed director of the Yale Observatory in 1884, carried out with a 6-in. heliometer, between the years 1885 and 1892, a determination of the distances of the ten brightest stars of the northern hemisphere. After these were finished the Yale observers, Elkin, Chase, and Smith, embarked on the ambitious programme of the determination of the distances of 163 stars of the northern hemisphere which show large proper-motion. They have added forty-one southern stars to these, and thirty-five stars of special interest. The results of all these observations were published in 1912. They have not, in most cases, the high accuracy of the Cape observations, but, nevertheless, are of great accuracy, and appear to be free from any considerable systematic error. A third important series of observations was made by Peter with a 6-in. heliometer at Leipzig. These were commenced about 1890, and continued until the death of Prof. Peter in 1911. The parallaxes of twenty stars were determined with the same high accuracy as the Cape observations.

Observations with the heliometer require both skill and industry. To secure the needful accuracy measures must be made in four different positions of the instrument, so that possible small systematic errors may be eliminated by reversal. Great care is required in the adjustments of the instrument, particularly in the accurate determination of the scale-value at different temperatures. The possibility of obtaining satisfactory results with less labour was considered by Kapteyn, in view of the successful determination of the parallax of Gr. 34 by Auwers. From 1885 to 1887 he made observations with the transit-circle at Leyden of fifteen stars for the purposes of determining parallax. The observation consisted in observing the time when the star the parallax of which was sought and two or three neighbouring stars crossed the meridian. Observations are made at the two most favourable epochs—say every night in March, and every night in September—to determine whether the star has changed its position relatively to its neighbours in the interval. The difficulties are twofold. The purely accidental error of observations of transits is considerable as compared with the small quantity which is sought. Besides this, the star of which the parallax is required is probably brighter than the comparison stars, and special precautions are required to guard against personal errors of the observer.

In questions of this kind the only satisfactory way is to judge by the results. From observations made on fifty nights, values of the parallax are obtained not nearly so accurate as the best heliometer observations, but still of considerable accuracy. Finally, the parallaxes of four of the stars which had been previously determined by measures with a heliometer showed satisfactory agreement.

This method has been employed by Jöst at Heidelberg, very extensively by Flint at the Washburn Observatory of the University of Wisconsin, and is now being tried at the Cape by Vouté, a pupil of Kapteyn's. It appears to me that this method can never give results of the highest accuracy, but that it may be of use in a preliminary search for stars of large parallax. The argument of the facility of the method

compared with the heliometer has, however, lost much of its force; for, as I hope to show next, the highest accuracy attainable with the heliometer can be secured much more easily with a photographic telescope.

The application of photography to the determination of stellar parallax was first made by Pritchard in Oxford between 1887 and 1889. He took a large number of photographs and measured on them the angular distance of the star which he was considering from four of its neighbours. In this way he determined the parallax of five stars. He began this work late in life, and it was left for others to develop the photographic method and find what accuracy could be attained with it. At first sight it seems very easy, but experience shows that there are a number of small errors which can creep in and vitiate the results, unless care is taken to avoid them.

It has gradually become clear that with a few simple precautions and contrivances, a greater accuracy can be reached in the determination of parallax by photography and with much less trouble than by any other method. Between 1895 and 1905, several astronomers succeeded in obtaining from a few plates results as accurate as could be obtained from many nights' observations with the heliometer by the most skilled observers. In the last five years a large number of determinations have been made. In 1910 Schlesinger published the parallaxes of twenty-five stars from photographs taken with the 40-in. refractor of the Yerkes Observatory, and in 1911 Russell published the parallaxes of forty stars from photographs taken by Hinks and himself at Cambridge. The opinion expressed by Gill on these observations (*M.N.*, vol. lxii., p. 325), was that but for the wonderful precision of the Yerkes observations, the Cambridge results would have been regarded as of the highest class. The facility with which the Yerkes results are obtainable is expressed very tersely by Schlesinger—"the number of stellar parallaxes that can be determined per annum, will in the long run be about equal to the number of clear nights available for the work." With the heliometer at least ten times as much time would have been required. During the last year two further instalments of the results of the Yerkes Observatory have been published by Slocum and Mitchell, giving the parallaxes of more than fifty stars. It might be thought that the high accuracy attained by them is largely attributable to the great length of the telescope. From experience at Greenwich, I do not think this is the case, and believe that similar results are obtainable with telescopes of shorter focal length. As several observatories are now occupied with this work, we may expect that the number of stars the distances of which are fairly well known will soon amount to thousands, as compared with three in 1838, about twenty in 1880, about sixty in 1900, and now perhaps two hundred.

The stars the distances of which have been measured have generally been specially selected on account of their brightness or large proper-motion. Each star has been examined individually. Kapteyn has suggested that instead of examining stars singly in this way, photography gives an opportunity of examining all the stars in a small area of the sky simultaneously, and picking out the near ones. The method has been tried by Kapteyn and others—among them Dr. Rambaut. The idea is very attractive, because it examines the average star and not the bright star or star of larger proper-motion. It is liable, however, to some errors of systematic character, especially as regards stars of different magnitudes. Comparison of the results so obtained with those found otherwise will demonstrate whether these errors can be kept sufficiently small by great care in taking the photographs. Until this is done no opinion can be expressed on the success of this experiment, which is worth careful trial.

The question may be asked, How near must a star be to us for its distance to be measurable? I think we may say ten million times the sun's distance. This corresponds to the small angle 0·02″ for the parallax. If a star's parallax amounts to this, there are, I believe, several observatories where it could be detected with reasonable security, though we shall know more certainly by the comparison of the results of different observations when they accumulate.

You will readily imagine that an accurate knowledge of the distances of many stars will be of great service to astronomy. There are ample data to determine the positions, velocities, luminosities, and masses of many stars if only the distances can be found. Thus we know the distance of Sirius, and we are able to say that it is travelling in a certain direction with a velocity of so many miles per second: that it gives out forty-eight times as much light as the sun, but is only two and a half times as massive. The collection and classification of particulars of this kind is certain to give many interesting and perhaps surprising results. But it is not my purpose to deal with this to-night. The task I set before myself in this lecture was to give an idea of the difficulties which astronomers have gradually surmounted, and the extent to which they have succeeded in measuring the distances of the stars.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Rev. T. C. Fitzpatrick, president of Queens' College, has been elected Vice-Chancellor for the coming academic year.

The council of the Senate has announced that the Board of Education has agreed to make a grant in aid of the medical departments of the University, and that the amount to be received on account of the present year is 5873*l.*; it proposes that a new committee, to be called the Medical Grant Committee, should be appointed for the purpose of administering the annual grant.

Mr. H. Scott, of Trinity College, has been appointed curator in entomology for five years from March last.

A grant of 50*l.* has been made from the Balfour Fund to enable Mr. G. Matthai, of Emmanuel College, to visit America in furtherance of his researches on the comparative anatomy and classification of the Madreporaria.

GLASGOW.—By an Order in Council dated May 27, 1915, the King has reappointed Sir Donald MacAlister and Mr. Otto Beit, and has appointed Mr. R. E. Prothero, to be members of the governing body of the Imperial College of Science and Technology for a term of four years from June 1, 1915.

LONDON.—Owing to Prof. Brodie's services being required for military purposes, the course of advanced lectures in physiology arranged to be given by him at King's College (as announced last week) will not be delivered.

OXFORD.—The report of the delegates of the University Museum for 1914, together with the departmental reports of the professors and readers teaching within the Museum, has just been published. In the general report attention is directed to the departure of large numbers of the teaching and service staff, and also of research workers, for military duties. This has affected both the Museum itself and also the several departments. Mention is made of the billeting of the 9th Battalion of the Hampshire Regiment for a night in some of the laboratories; of the presentation to the University of Mr. Hope Pinker's

statue of Roger Bacon; and of the completion of the carving in the upper corridor, under the bequest of the late Rev. H. T. Morgan.

The report of the Professor of Pathology records the fact that from an early date in August the department and the whole of its staff were engaged in services connected with the war. About 6000 inoculations were performed, and a quantity of vaccine was sent to Belgium. The Professor of Physiology includes in his report a tribute to the services rendered by the late Dr. G. J. Burch, F.R.S., and an account of the arrangements for the memorial to the late Prof. Francis Gotch, F.R.S. Most of the departmental reports, including that of the Curator of the Pitt-Rivers Museum, contain long lists of donations to the respective collections, and full records of the research work which, in spite of all obstacles, has been carried on in the various laboratories and workrooms of the Museum.

The new building for engineering science was finished at Christmas. The new chemical laboratory is still in course of erection, but the professor hopes that it will be ready for occupation by next October.

Science announces that the Michigan Legislature has granted 70,000*l.* for the erection of a new university library building for the University of Michigan.

THE fiftieth anniversary celebration of the Worcester Polytechnic Institute, Worcester, Massachusetts, is to be held on June 6–10. President Wilson, who gave the opening address on a similar occasion twenty-five years ago, hopes, if the pressure of public business makes it possible, to attend the meetings on June 9. General G. W. Goethals has also accepted an invitation to be present. On June 10, honours are to be conferred and various bronze tablets unveiled.

A FREE scholarship of the value of 30*l.*, open to all-comers, and tenable at the Northampton Polytechnic Institute (London), is being offered to students. In view of the opportunities for advancement which the calling and craft of optics now offer on account of the shutting off of alien supplies due to the war, the "Aitchison Memorial Scholarship," which has for its special object the encouragement of recruits for the optical industry, should prove very attractive to intelligent youths. The subjects of examination include English, mathematics, and elementary physics. The conditions of the scholarship have been laid down by a committee which includes Dr. R. Mullineux Walmsley, Prof. Silvanus P. Thompson, and Dr. J. W. Ettles. Full particulars can be had of the hon. secretary and treasurer, Mr. Henry F. Purser, 35 Charles Street, Hatton Garden, London, E.C.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 20.—Sir William Crookes, president, in the chair.—H. **Moore**: The corpuscular radiation liberated in vapours by homogeneous X-radiation.—H. **Richardson**: The absorption in lead of γ rays emitted by radium B and radium C. (1) The absorption curves in lead of the radiations emitted by radium B and radium C have been determined and analysed. (2) In addition to the penetrating type of radiation for which $\mu=0{\cdot}5$ (cm.$^{-1}$) in lead, radium C has been found to emit soft types for which $\mu=46$, $\mu=6{\cdot}0$, and $\mu=1{\cdot}5$, and which are practically absorbed by 1·5 cm. of lead. (3) The analysis of the radium B absorption curve shows that in addition to the radiation $\mu=40$ in aluminium, the rays emitted consist of three types for which $\mu=46$, $\mu=6{\cdot}0$, and $\mu=1{\cdot}5$ for lead. The close similarity of this latter radiation with that of the soft portion emitted by radium C, already observed by Rutherford and Andrade, has been established. (4) The absorption of the radiations in different elements has been examined and the bearing of the results discussed. No evidence of anomalous absorption has been found in the case of the penetrating radiations.—T. R. **Merton**: The application of interference methods to the study of the origin of certain spectrum lines. By measuring the limiting orders at which interference can be detected for different radiations, certain deductions may be made as to the mass of the luminous particles and the temperature of the source. If the only circumstance which could possibly influence the width of spectrum lines at low pressures were the Doppler effect due to the motion of the luminous particles in the line of sight, the relative masses of particles emitting radiations from the same source of light might be calculated. As, however, there is reason to doubt the validity of this assumption under certain conditions, the conclusions which may be drawn with certainty from measurements of this kind are an inferior limit for the mass of the luminous particles if the temperature of the source is known, or a superior limit to the temperature if the mass of the luminous particles is assumed. It is shown in the paper that the flame lines of calcium, strontium, and barium are probably due to molecules, whilst the H and K lines of calcium are to be attributed to calcium atoms. As the flame lines are members of series, it must be recognised that radiations from molecules may give rise to line series as well as band spectra. Lines of the two spectra of argon have been investigated. The width of the lines of the red spectrum would appear to be accounted for by the Doppler effect. The lines of the blue spectrum are very broad in comparison with those of the red spectrum, and a satisfactory explanation of this has not been found. Spectrum lines of the "arc" type are broadened when condensed discharges are used as the method of excitation, but the difference in width of the lines in the blue and red spectra of argon is of another order of magnitude. The band spectrum associated with helium has been found to be enhanced when the gas is cooled to the temperature of liquid air, which might justify the suspicion that more than one atom was concerned in its production, but a comparison of the widths of the lines in the band spectrum with the ordinary helium lines makes it extremely probable that the band spectrum is due to atomic helium.

Physical Society, May 14.—Dr. A. Russell, vice-president, in the chair.—E. H. **Rayner**: Precision resistance measurements with simple apparatus. The paper describes methods by which the comparison of resistances can be made to an accuracy of 1 in 10,000 or higher by using simple apparatus usually available in electrical laboratories, or which can be easily constructed with little skilled assistance. The comparison of nominally equal resistances of 1 ohm and upwards by the usual method of shunting one side of a nearly balanced quadrilateral by a high resistance is mentioned, and variations on this when only part of one resistance is shunted are often useful. The great advantages of having resistances capable of carrying comparatively large currents are illustrated, especially for measuring changes of resistance of commercial apparatus under working conditions. The determination of errors in a volt box for use with a potentiometer is described at some length. This is of especial importance in precision photometry. If a sufficient continuous-current voltage is not available for testing such apparatus as high-potential dividers, it is shown that using sufficient continuous current to secure sensitivity the heating may be supplied by superposed alternating current. Resistances in common use are

very generally of simple numerical value, and a Kelvin bridge specially designed for the comparison of such resistances is described. It consists essentially of two rows of 25 resistances of 20 ohms each.—G. F. W. **Jordan**: Some novel laboratory experiments. (1) Condensation calorimeters for the measurement of latent and specific heats. (*a*) It is shown how an ordinary vacuum jacket flask can be converted into a suitable condensation calorimeter. Errors arising from loss of heat and wetness of the vapour are almost eliminated by making two experiments. (*b*) Another condensation calorimeter is constructed on a different plan with a view to the elimination of the same errors. (2) The thermal conductivity of a narrow metal bar. Gray's apparatus for the measurement of the conductivity of a narrow bar has been modified for the purpose of rendering the loss of heat relatively small and reducing the time taken in the measurement, thus introducing the experiment to the elementary student. (3) The measurement of Poisson's ratio for a rectangular lath. Two mirrors are attached to opposite sides of the bent lath for the measurement of the anti-elastic radius of curvature, and Poisson's ratio is then deduced from the observations in the usual manner. (4) A method of measuring the coincidence period of a kater and a clock pendulum. The kater and the clock pendulums are electrically connected so that when at the centres of their swings a momentary current passes through a telephone receiver. (5) A differential telephone receiver. An ordinary receiver is connected to the secondary of a simple differentially wound transformer, and it is thus converted into a differential receiver for the purpose of electrical measurement. (6) Experiment on interference fringes. The fringes produced by a Lloyd's mirror in white light are nearly achromatised by a simple grating on smoked glass. Other suggestive interference effects with the grating are also described. —S. **Butterworth**: Electrically maintained vibrations.

Royal Meteorological Society, May 19.—Major H. G. Lyons, president, in the chair.—Dr. H. R. **Mill** and H. E. **Carter**: The wet winter of 1914–15. The authors dealt fully with the abnormal rainfall of the four months, November, 1914, to February, 1915, and showed that the general rainfall for England and Wales for this period was 20·21 in. A striking feature of the comparison with the average is that the area with less than 12 in. of rain was barely one-tenth part of the area on the average map, while the area with more than 30 in. was nearly seven times as great as on the average map. December was by far the wettest month, the general rainfall being 211 per cent. of the average; in November it was 134 per cent.; in January 143 per cent.; and in February 198 per cent. of the average. The persistent nature of the rainfall caused extensive floods over practically all the low-lying parts of the country. The wettest previous winters were those of 1876–77 and 1911–12, that of 1914–15 was shown to be wetter than either of them. —J. E. **Clark**: Report on the phenological observations from December, 1913, to November, 1914. The report was based on the returns from 133 stations in various parts of the British Isles. This was the fourth successive mild year, the mean date for the plant records being a week earlier than the average. The dominating factors were the abnormally mild autumn of 1913, the mild winter, and remarkably genial April weather. Fruits and crops were prejudiced by the serious May frosts and droughty conditions from mid-April to October; on the other hand, the sunny warmth of the autumn largely contributed to make the year successful for the farmer and partially so to fruit-growers.

PARIS.

Academy of Sciences, May 25.—M. Ed. Perrier in the chair.—S. **Lattès**: Linear multiplicities invariant by a given linear substitution.—Ed. **Bourquelot**, M. **Bridel**, and A. **Aubry**: The biochemical synthesis of the α-mono-d-galactoside of ethylene glycol. The galactoside was obtained by the action of an extract of low yeast upon an aqueous solution of ethylene glycol and galactose during a period of nine months. A description is given of the process of purification, which offered some difficulties, and of the physical properties and hydrolysis of the α-galactoside.—Alphonse **Berget**: The capillary constant of sea water. From measurements of the surface tension of sea water and of distilled water it is shown that the difference is sufficiently great to cause an error in density measurements made with a hydrometer of rather more than one part in a thousand.—Pierre **Lesage**: The pedicels of *Lunularia vulgaris*.—Eugène **Pittard**: Comparative anthropometry of the Balkan peoples. Supplementing an earlier paper with statistics of the cephalic index and anthropometric characters of the face.—Jules **Glover**: Telephony without transmission of the sound waves through air.—Jean **Villey**: A method for the radioscopic localisation of projectiles in the human body. The series of operations required by the one method are purely mechanical and dispense with calculations or photographic plates. Full details of the technique are given.—J. P. **Dubarry**: Anti-typhoid vaccination by the gastro-intestinal method. A comparison of the results obtained by the hypodermic and gastro-intestinal methods of inoculation.—E. **Roubaud**: The destruction of flies and the disinfection of bodies in the war zone. The use of cresylic acid, heavy tar oil, and ferric sulphate are recommended, and the specific action of each of these described.

CAPE TOWN.

Royal Society of South Africa, April 21.—Dr. L. Péringuey, president, in the chair.—Dr. L. **Péringuey**: *Presidental Address*:—"The Bushman as a Palæolithic Man."—Ethel M. **Doidge**: Some notes on the South African Erysiphaceæ. The paper consists of notes on the South African representatives of the "powdery mildews." These cause a number of widely distributed and more or less destructive diseases of plants in this country; but they are not easily identified owing to the almost invariable absence of perithecia. The species occurring in South Africa are enumerated, and a list given of the specimens contained in the Union Mycological Herbarium, Pretoria. Two new specimens of the genus Uncinula are described.—A. W. **Rogers**: Geitsi Gubib, an old volcano: A geological description is given of Geitsi Gubib, a ring-shaped mountain in German South-West Africa, rising about 5200 ft. above sea-level, and a conspicuous object from the railway north of Keetmanshoop. The description is based on notes taken during a stay by the author of two days on the mountain, and on the examination of the rocks brought away.

BOOKS RECEIVED.

Pendlebury's New Concrete Arithmetic. By C. Pendlebury and H. Leather. Sixth Year. Pp. 80. (London: G. Bell and Sons, Ltd.) 6*d*.

Experimental Electricity and Magnetism. By M. Finn. Pp. x+436. (London: G. Bell and Sons, Ltd.) 4*s*. 6*d*.

Plants and their Ways in South Africa. By Dr. B. Stoneman. New edition. Pp. xii+387. (London: Longmans and Co.) 5*s*.

Experimental Plant Physiology for Beginners. By

L. E. Cox. Pp. vii+111. (London: Longmans and Co.) 2s. net.

Union of South Africa. Department of Agriculture. Report with Appendices for the Year, April 1, 1913, to March 31, 1914. Pp. 299. (Cape Town: Cape Times, Ltd.) 7s. 6d.

Zròdla Podświadomości i jej Przejawy. By E. Abramowski. Pp. 207 (Warszawa: Drukarnia Polska.) 1.50 kop.

Podstawy Naukowe Elektrotechniki Lacznie Z Zasadami Pomiarów, M. Pozaryski. Pp. x+415. (Warszawa: Gebethnera i. Wolffa.) 2.40 kop.

Institut Psychologiezny W Warszawie. Prace z Psychologii Dòswiadczalnej. Edited by E. Abramowskiego. Tom. ii. Pp. xii+362. (Warszawa: Gebethnera i. Wolffa.) 1.80 kop.

Zagadnienia dotyczace gieometrji Elementarnej zebral i Ulożyl F. Enriques. Tom. i. Pp. iv+331. (Warszawa: Gebethnera i. Wolffa.) 1.50 kop.

Towarzystwo Naukowe Warszawskie. By E. Loth. Pp. v+71. (Warszawa: Gebethnera i. Wolffa.) 75 kop.

M. Faraday Dzieje Swiecy szesc wykladòw popularnych W. Przekladzie Marji i. Stanislawa Kalinowskich. (Warszawa: Gebethnera i. Wolffa.) 50 kop.

Biblioteka Matematyczno-Fizyczna. Serva iii. x. Teorya Liczb (Kurs Uniwersytecki). Dr. W. Sierpiński. Pp. xiv+412. (Warszawa: Gebethnera i. Wolffa.) 1.80 kop.

The Limitations of Science. By Prof. L. T. More. Pp. 268. (New York: H. Holt and Co.) 1.50 dollars net.

Wisconsin Geological and Natural History Survey. Bulletin No. xxxiii. Scientific Series. No. 10. The Polyporaceæ of Wisconsin By J. J. Neuman. Pp. 206+xxv plates. Bulletin No. xli. Economic Series. No. 18. A Study of Methods of Mine Valuation and Assessment, with Special Reference to the Zinc Mines of South-western Wisconsin. By W. J. Uglow. Pp. 73. (Madison, Wis.)

Surface Tension and Surface Energy and their Influence on Chemical Phenomena. By Dr. R. S. Willows and E. Hatschek. Pp. viii+80. (London: J. and A. Churchill.) 2s. 6d. net.

Plant Breeding. By L. H. Bailey. New edition. Revised by Dr. A. W. Gilbert. Pp. xviii+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 8s. 6d. net.

Royal Botanic Gardens, Kew. Hand-list of Tender Monocotyledons, excluding Orchidaceæ, cultivated in the Royal Botanic Gardens. Second edition. Pp. 241. (London: H.M.S.O.: Royal Gardens, Kew.) 1s. 6d.

The Book of the Fly. By G. H. Hardy. Pp. 124. (London: W. Heinemann.) 2s. 6d. net.

DIARY OF SOCIETIES.

THURSDAY, JUNE 3.

ROYAL SOCIETY, at 4.30.—The Shapes of the Equipotential Surfaces in the Air near Long Buildings or Walls, and their Effect on the Measurement of Atmospheric Potential Gradients: Prof. C. H. Lees.—The Influence of Gases on the Emission of Electrons and Ions from Hot Metals: Prof. O. W. Richardson.—The Band Spectrum associated with Helium: J. W. Nicholson.—Soil Protozoa and Soil Bacteria: E. J. Russell.—The Chromosome Cycle in Coccidia and Gregarines: C. Dobell and A. P. Jameson.

ROYAL INSTITUTION, at 3.—Methods of presenting Character in Biography and Fiction: Wilfrid Ward.

FRIDAY, JUNE 4.

ROYAL INSTITUTION, at 9.—Radiations from Exploding Atoms: Sir E. Rutherford.

GEOLOGISTS' ASSOCIATION (at University College), at 8.—Lakes and their Origin, with Special Reference to Rock-basins: Prof. E. J. Garwood.

MONDAY, JUNE 7.

ROYAL INSTITUTION, at 3.—Method of Presenting Character in Biography and Fiction: Wilfrid Ward.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—A New Process for the Refining of Chile Saltpetre: J. B. Hobsbaum.—A Method of Testing Mineral Lubricating Oils for use in Forced Lubricating Systems for Steam Turbines: Arnold Philip.—The Application of Adobe as a Material for the Construction of Buildings for the Manufacturing and Storing of Explosives: Major Ferriz.

VICTORIA INSTITUTE, at 4.30.—The Old and New Versions of the Babylonian Creation and Flood Stories: Dr. T. G. Pinches.

ARISTOTELIAN SOCIETY, at 8.—Some Theories of Knowledge: Dr. F. Aveling.

TUESDAY, JUNE 8.

ROYAL INSTITUTION, at 3.—The Evolution of Steel—Influence on Civilisation: Prof. J. O. Arnold.

ZOOLOGICAL SOCIETY, at 5.30.—The Feet and Glands and other External Characters of the Paradoxurine Genera Paradoxurus, Artictis, Arctogalidia, and Nandinia: R. I. Pocock.—The Skull of an Extinct Carnivore related to Aeluropus, from a Cavern in the Ruby Mines, Mogok, Burma: Dr. A. Smith Woodward.—The Early Development of the Heart and Anterior Vessels in Marsupials, with Special Reference to Perameles: Miss K. M. Parker.—The Triassic Stegocephalians, Brachyops, Bothriceps, and Lydekkerina, gen. nov.: Dr. R. Broom.

WEDNESDAY, JUNE 9.

GEOLOGICAL SOCIETY, at 8.—The Accessory Minerals of the Granitic Rocks of the English Lake District: R. H. Rastall and W. H. Wilcockson.

THURSDAY, JUNE 10.

ROYAL INSTITUTION, at 3.—Method of Presenting Character in Biography and Fiction: Wilfrid Ward.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—The History of the Gradual Development of the Groundwork of Geographical Science: Sir Clements Markham.

INSTITUTE OF ACTUARIES, at 5.—Annual General Meeting.

FRIDAY, JUNE 11.

ROYAL INSTITUTION, at 9.—Music and Poetry: Dr. H. W. Davies.

ROYAL ASTRONOMICAL SOCIETY, at 5.

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